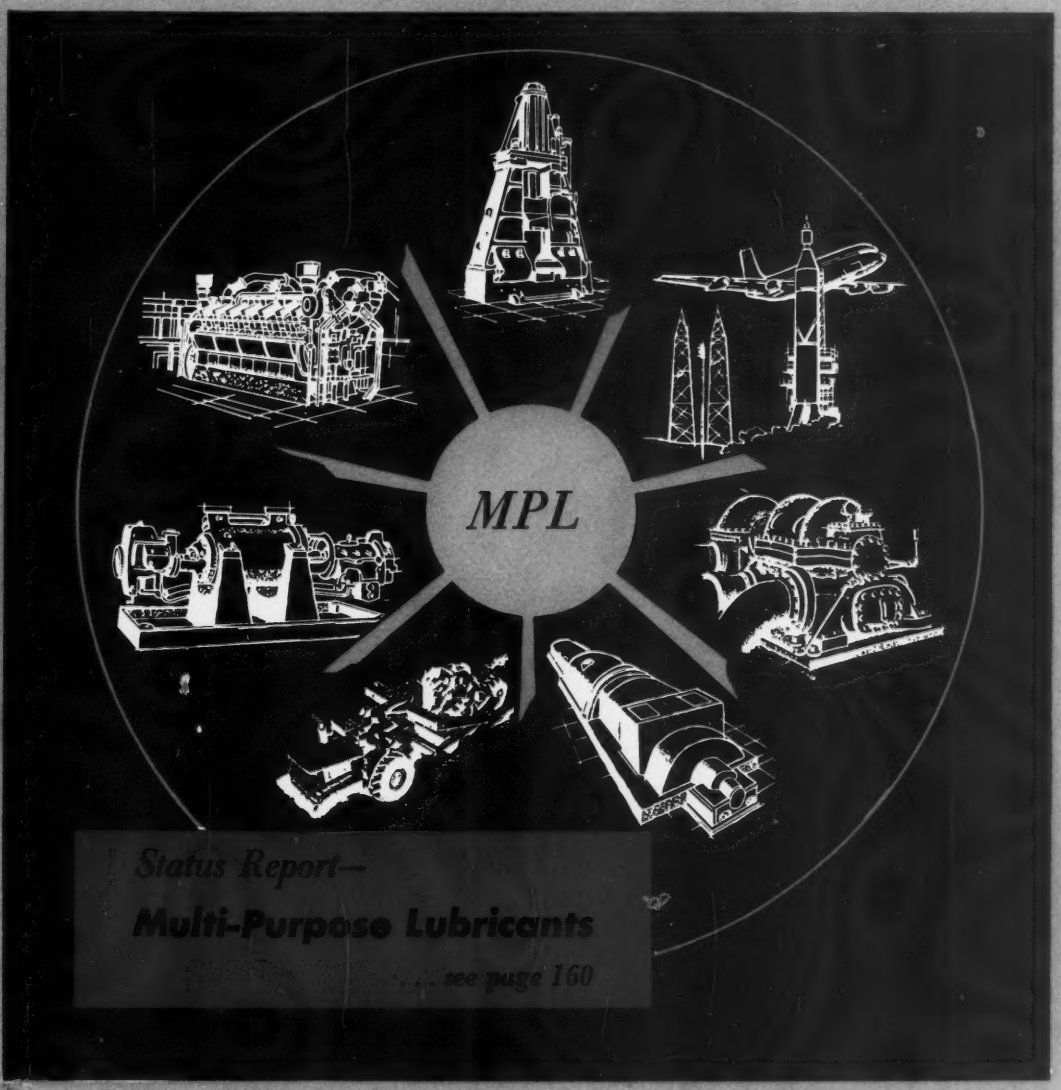
Vol. 17, No. 4 April, 1961

LUBRICATION ENGINEERING

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE



Status Report—
Multi-Purpose Lubricants
... see page 160

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Volume 17, No. 4
April, 1961

Lubrication Engineering

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

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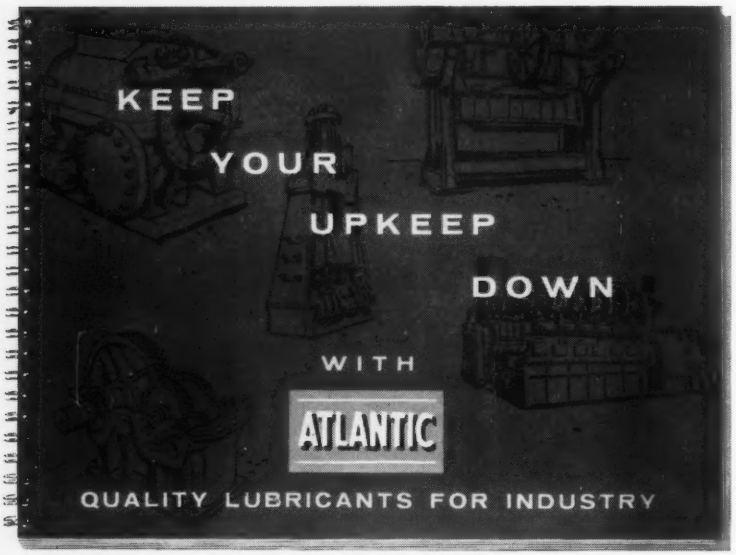
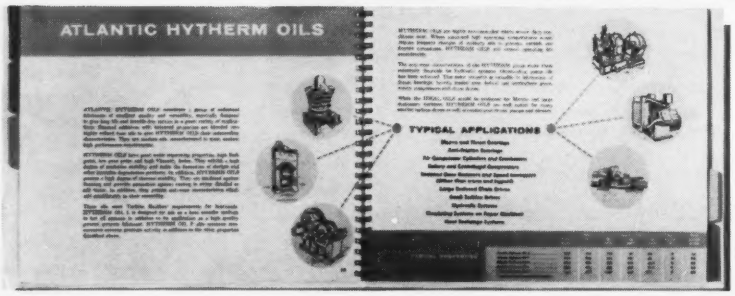
A NEW 60-page booklet that simplifies selection of the best lubricants for your needs. The Atlantic Refining Company has prepared this handsome new booklet as a modern guide to good lubrication. Called, "Keep Your Upkeep Down with Atlantic Quality Lubricants for Industry," it gives complete information—including typical properties and applications. ■ For easy reference, the products are classified and color coded according to their basic functions. And of special interest to lubrication engineers is a correlation of lubricant viscosity with speed, radius and clearance, which provides a quick, practical way to determine suitable viscosity for journal bearings. ■ Whatever your lubricant requirements, you're sure to find this comprehensive booklet a useful addition to your reference files. For your free copy, simply write to The Atlantic Refining Company, 260 South Broad Street, Philadelphia 1, Pa., giving your title and company name. We'll see that your booklet reaches you without delay.





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LUBRICATION IN THE NEWS

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USAF REPORT PROVIDES TIPS FOR BROACHING HOT METALS

Ways to improve and extend the application of broaching to high temperature alloys are explained in a state of the art study of the broaching process compiled by the Air Force and released to science and industry through the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce, Washington 25, D. C.

Based largely on information obtained directly from 51 U. S. and European broach tool and machine makers, the study covers broach cutting and tool life, materials, and surfaces, as well as economic and design factors and current developments in the industry.

Survey of the Broaching Process. B. Hanna and C. E. Eppinger, University of Denver, for AMC Aeronautical Systems Center, U. S. Air Force. Jan. 1960. 122 pages. (Order PB 161 776 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Price $2.75.)

The state-of-the-art study of the broaching process explains ways of extending broaching for high temperature alloys, and offers suggestions for solving current broaching problems. The study—based largely on information obtained by interviews and questionnaires from 51 U. S. and European broach tool and machine makers—covers broach cutting and tool life, materials and surfaces, plus economic and design factors and current developments in the industry. In analyzing the impact of high temperature alloys and their effect on broach equipment life, the report points out that although some manufacturers have produced ingenious broaching machines for specialized jobs, the configuration of most broaching tools is harmful to cutting action. The survey showed that these machines generate increased tool-chip friction causing a decrease in the shear plane angle with resulting higher shear plane temperatures. Additional information on cutting tooth geometry and gullet design is offered as possible partial remedies to the heat-friction problem. The report recommends the development of a new technique for rapid evaluation of cutting fluids as another means of reducing tool-chip friction and lowering cutting temperatures.

Also available from OTS is an Air Force study of the machining characteristics of a molybdenum alloy containing one half percent titanium, covering face milling, turning, drilling, reaming, and tapping operations.

Machining Characteristics of High Strength Thermal Resistant Materials: Item 5, Part 2—Machining Characteristics of Molybdenum—0.5% Titanium Alloy.

L. J. Nowikowski, Metcut Research Associates Inc., for the Air Material Command, U. S. Air Force, May 1960. 70 pages. (Order PB 161 775 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Price $2.)

Machining characteristics of a molybdenum alloy containing one half percent titanium were evaluated for turning, face milling, drilling reaming, and tapping operations. The tests were conducted to determine machining conditions suitable for production operations of this alloy. This particular combination of molybdenum and titanium was selected as being typical of currently valuable molybdenum alloys. Graphs compiled from the various machining tests show relationships between tool life, cutting speed, feed, tool geometry, tool material and cutting fluids. Force measurements were made for turning and drilling the test alloy, showing the effect of machining variables on unit power, coefficient of friction and tool forces. (Source: OTS, United States Department of Commerce.)

DETROIT SITE OF 1961 DESIGN ENGINEERING SHOW, MAY 22-25

The machine design division of the American Society of Mechanical Engineers will sponsor their exposition and the concurrent conference in Detroit's newly opened Cobo Hall, May 22-25, 1961.

The area of discussion in the conference will be greatly expanded, with a number of extra sessions being planned to permit more intensive consideration of several aspects of design engineering.

Both show and conference are devoted to the research and development aspects of new products of all types. Materials and component parts for virtually every kind of manufactured product, from everyday household items to space ships, will be shown. (Source: American Society of Mechanical Engineers)

CUTTING "DOWN TIME"

By instituting a systematic inspection and lubrication program, Fox River Paper Corp. of Appleton, Wis., cut over-all maintenance charges to about $132,000 in 1960 from $190,000 four years ago. These costs include "down time" on each of the two big paper machines at the plant; for each hour one of the machines is unfit for operation, the maintenance department is charged $200 because of lost production.

"We used to play it by ear on lubrication and we weren't particularly worried about substituting a barrelful of this lubricant for a barrelful of that—but no more," reports M. H. Buhner, chief engineer. "Now our men follow carefully detailed lubricating instructions right to the letter. We have separate books for nearly every machine we have." (Wall Street Journal, March 7, 1961.)

NEW YORK SITE OF 1961 ASTME CONVENTION

Highlighting the 1961 Convention of the American Society of Tool and Manufacturing Engineers in the New York Coliseum, May 22 to 26, will be an exposition of creative manufacturing equipment and an engineering conference.

Technical sessions, plant tours, Tech Tours, a seminar and a special public affairs program have been designed to survey new processes and techniques, giving the manufacturing engineer a panoramic picture of industrial progress. (Source: American Society of Tool and Manufacturing Engineers)

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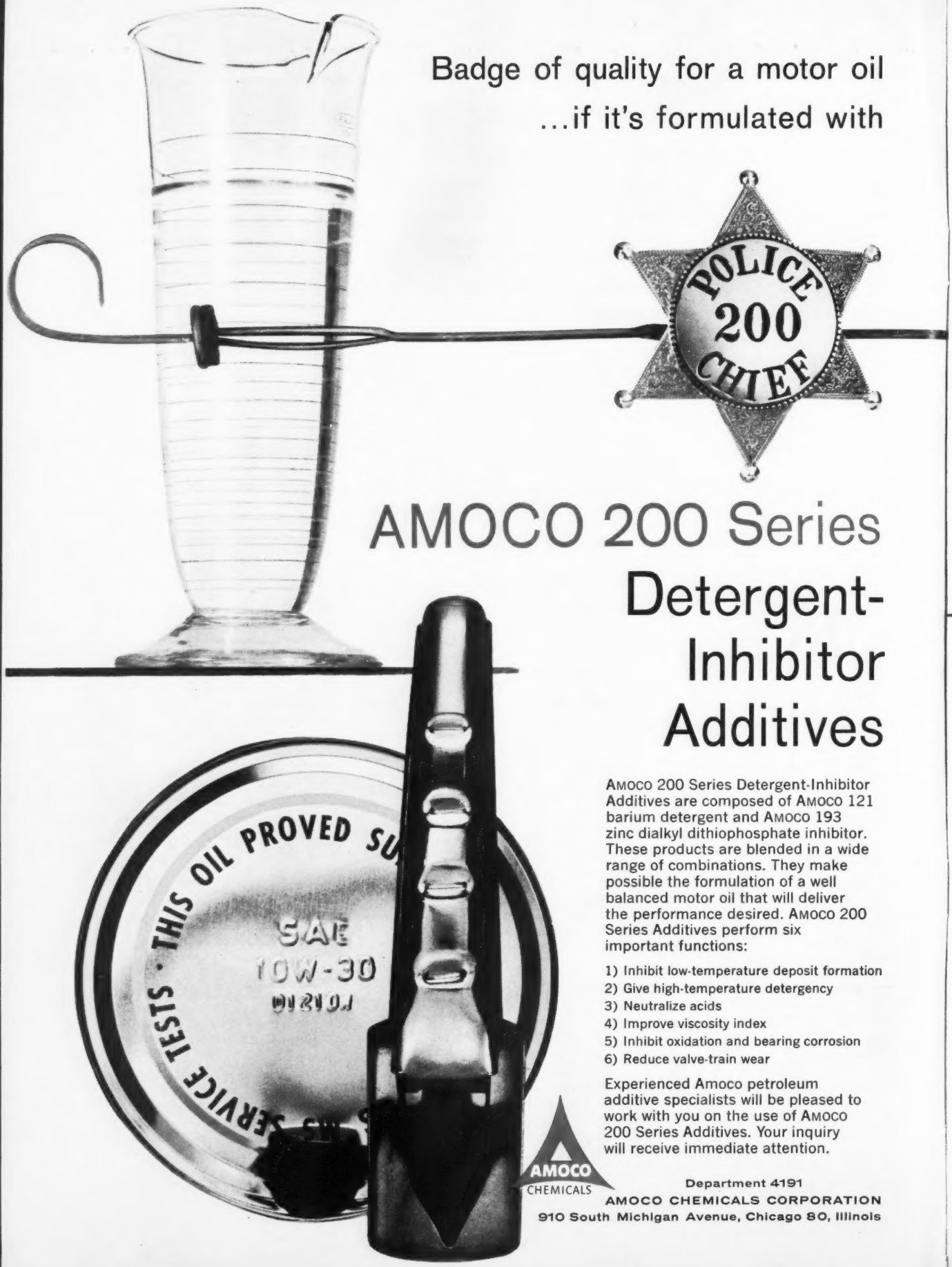

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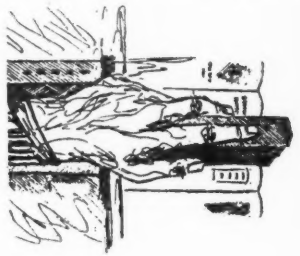

Available ASLE Publications for your Engineering Library...

Interpreting Service Damage In Rolling Type Bearings

A manual on ball and roller bearing damage with drawings, tables, and 74 photographs for aiding in the classification and identification of the causes of many of the common types of bearing damage. $1.00 per copy, $2.00 Foreign.

Industrial Dermatoses—Protection, Prevention and Treatment

Eight experts in the field of industrial dermatitis assemble for the first time their experience and investigation in an ASLE-sponsored effort to curb these costly diseases. The experts examine the use and handling of cutting oils, lubricants, and solvents. Protective measures such as ointments, housekeeping, and preventing bacterial decomposition are discussed. $1.00 per copy, $2.00 Foreign.

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NEW PRODUCTS

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DOUBLE PUMP POWER UNITS ANNOUNCED

A new line of 1000 and 2000 p.s.i. Double Pump Power Units for general industrial service has been announced by the Hannifin Company, Des Plaines, Illinois, a division of Parker-Hannifin Corporation.

The Hannifin "DCP" power unit is offered in standard 30 and 60 gallon reservoir sizes, with combined pump capacities to 33 g.p.m. All units incorporate an 1800 r.p.m. motor.

By utilizing double pumps in conjunction with the "Hi-Lo" Unloading Valve Panel, horsepower requirements are reduced, oil temperatures are lowered, and maximum circuit efficiency is realized. Hannifin Double Pump Units give ideal service in situations where rapid advance and slow, constant feed is desired. "DCP" power units can also be supplied with two individual relief valves instead of the "Hi-Lo" Panel, when two separately operated hydraulic systems are required.

Circle No. 1 on Reader Service Card

NEW DESIGNS AVAILABLE IN LABORATORY FILTERS

A newly redesigned line of porous stainless immersion tubes, beaker filters, and gas dispersion tubes is now available from Micro Metallic Division of Pall Corporation, Glen Cove, N. Y. These units feature type 304 stainless steel tubes heliarc welded to the center of type 316 porous stainless steel filter elements. Elements are dished to a spherical radius.

The filters are available in five porosity grades, with average pore openings of 65, 35, 20, 10 and 5 microns. They can be heated to 400 C without change of weight due to oxidation. Combining light weight and high flow rates with resistance to thermal or mechanical breakage, they are suitable for a variety of laboratory uses.

The relative chemical inertness of these units makes them useful with all alkalis, hot or cold, and with most acids. They can be cleaned by backwashing or by chemical treatment.

Circle No. 2 on Reader Service Card

NEW LUBRICATING SPRAY NOZZLES MANUFACTURED

For handling lubricating oils and solvents, a new line of precision spray nozzles is now being manufactured by Associated Precision Industries, Chicago. The spray nozzles are available in a wide range of standard nozzles in brass, monel, steel, stainless steel, hard rubber, and Teflon and in a variety of spray patterns. Standard nozzles are manufactured in a wide range of orifice diameters from .010" to .546" and in a selection of 11 different spray angles, and in pipe sizes from ⅛" NPT. to 1" NPT. in both female and male connections.

To give flexibility in meeting various spraying conditions, special nozzles will be engineered to exact specifications to cover any practical spray applications of spray pattern, nozzle material, orifice diameter, spray angle or other nozzle characteristic, where reasonable production quantities are involved.

Circle No. 3 on Reader Service Card

NEW TRICO FULL FLOW DISPENSERS

A new line of heavy duty dispensers, manufactured by Trico Fuse Mfg. Co., deliver a full flow of oil or other liquids by gravity when valve is opened, through ¼" O.D. Nylon or metal tubing from a central location. The flow stops when the valve is closed. Single or multiple sight feed valves should be used for adjusting the rate of feed since these dispensers have no means for feed regulation. Two types are available: one is manually controlled by a shut-off lever at the top of the reservoir, the other is electric solenoid operated and is completely automatic. Made in 5 sizes; 10 oz., 1 pt., 1 qt., 2½ qts., and 1 gallon. Liquid supply is always visible.

Circle No. 4 on Reader Service Card

MINIATURE CHECK VALVES ANNOUNCED

A new lightweight, miniature in-line check valve that permits free fluid flow in one direction and checks reverse flow, has been announced by Fluid Regulators Corporation, Painesville, Ohio.

The valve is designed with one end for installation into a valve body and the opposite end for tube connection. The design features large straight-line flow passages which assures low pressure drop and minimum loss of power.

Weighing less than 1 oz., the valve is built for operating pressures up to 1,000 psi, the valve cracks at 5 to 8 oz./in. and has a flow capacity of 1.0 gpm. It handles any fluid compatible with the materials in a −65 F. to +450F. temperature range.

Circle No. 5 on Reader Service Card

SHATTERPROOF TRANSPARENT BOWLS FOR AIR LINE FILTERS AND LUBRICATORS ANNOUNCED

A new unbreakable, transparent bowl for their air line filters and lubricators has been announced by the C. A. Norgren Co. Englewood, Colorado.

The new bowls are fully transparent, yet are said to be so tough that they will not break or shatter, offering superior resistance to solvents, oils, or corrosive gases. Recommended maximum operating conditions for the new bowls are 250 psi at temperatures up to 200 F—200 psi at temperatures reaching 250 F.

Circle No. 6 on Reader Service Card

RAPID REVERSING MOTORS NOW AVAILABLE

Louis Allis Rapid Reversing Motors are available in a complete line of integral HP, polyphase ratings offered in Open Drip-Proof, Totally Enclosed Fan-Cooled and Non-Ventilated enclosures. These are also available in Blower-Cooled constructions that incorporate an integrally mounted blower to supply a continuous unidirectional supply of air for maximum cooling and reversing capacity.

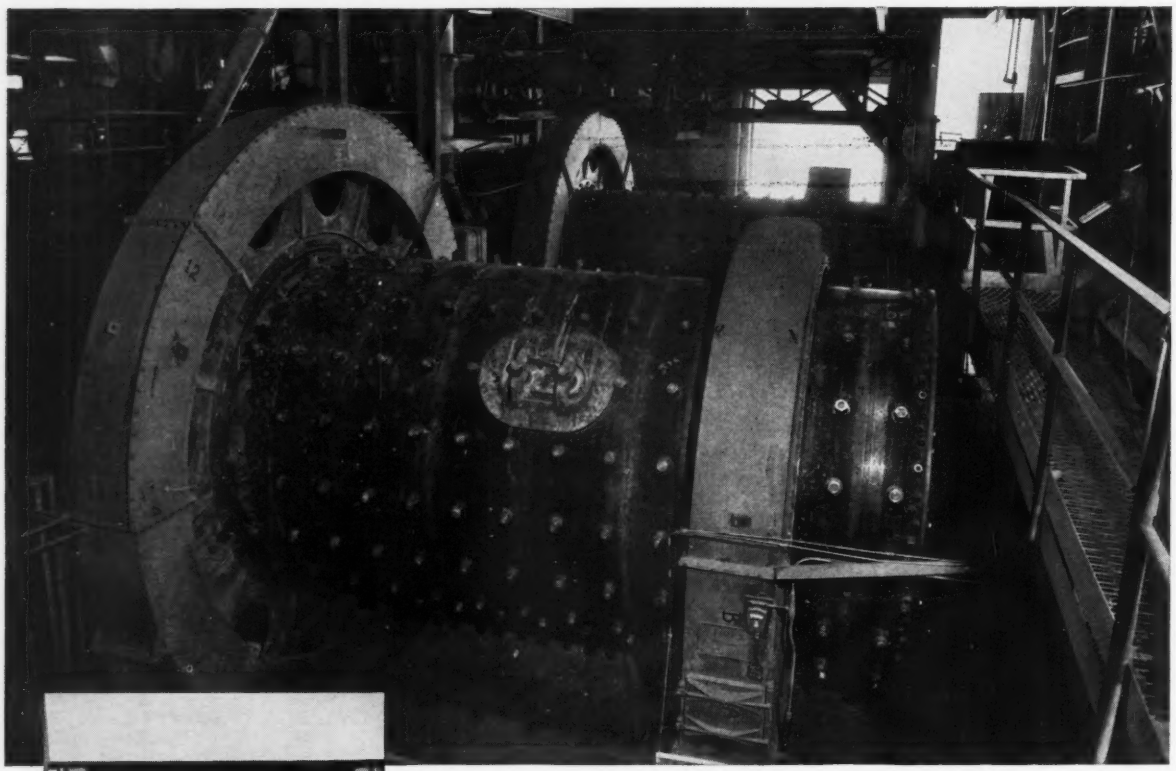
They are primarily designed for high production Machine Tool applications, offering up to 125 idle reversals per minute in the smaller sizes with open type construction and can be built to exceed 200 idle reversals per minute with Blower Cooled designs.

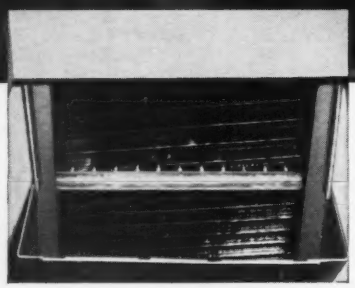
Circle No. 7 on Reader Service Card

(*Continued on page* 147)

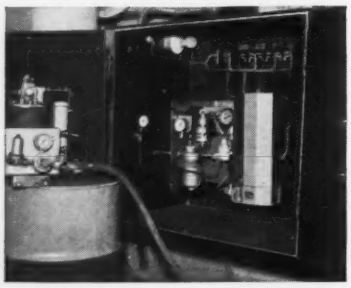
AUTOMATIC, CONTINUOUS LUBRICATION OF 15-FT. GEAR TRAINS WITH 3 PINTS OF LUBE PER DAY!

Ball mills in the Oro Grande, Calif., plant of Riverside Cement Co., (gear trains up to 15 ft. in diameter with faces up to 26 inches) now run smoother than ever before with Alemite's Oil-Mist with Thermo-Aire.





Heavy-viscosity lubricant from a conveniently located 55-gallon barrel is fed to gears by means of Alemite's Thermo-Aire system for best possible lubrication!



Lubricant consumption has been cut from 9-12 gallons per day to 3-pints in 24 hours to lubricate three huge ball mills.

Additional units are to be installed to lubricate 19 gear trains (both mill and kiln) with a reduction in lube from 3-5 drums per week to an estimated *one drum every 14 days!*

Housekeeping—once a costly nuisance—practically eliminated.

Alemite's Oil-Mist with Thermo-Aire dispenses lubricating oils up to 25,000 SSUV at 100 degrees F—no thinner needed.

Where gears are large, loads heavy (as at Riverside), Alemite's Oil-Mist with revolutionary Thermo-Aire may be your answer.

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Alemite has just completed a 20-page brochure, "Riverside Cement, A Success Story Every Mill Superintendent Should Read." Send today for your FREE copy and an illustrated brochure on Oil-Mist with Thermo-Aire.

NEW PRODUCTS

(Continued from page 145)

NEW PRECISION NEEDLE VALVE ENGINEERED

To meet modern industrial and professional needs for a low cost valve that resists corrosion, providing close control of troublesome fluids, Oscar Davis Co. has added to its regular line of pipe fittings, an all-machined needle valve in 4 sizes.

The Davis poly-vinyl chloride (PVC) needle valve is available in ⅛", ¼", ⅜" and ½" sizes with either threaded or socket ends. It is supplied with rubber compound "0" ring bonnet gasket and stem seal, providing guaranteed sealing action with low assembly torques as well as ease of operation. Rated 100 psi at 73.4 F, the valve is said to handle liquids and gases up to 150 F with half the room temperature rating, and works equally well at sub-zero temperatures.

Circle No. 8 on Reader Service Card

NEW OIL CONDITIONER AND GUM SOLVENT DEVELOPED

A new Oil Conditioner and Residual Gum Solvent designed to put new life in gasoline and diesel engines has been announced by Winslow Engineering and Manufacturing Company of Oakland, California. Known as CP, Conditioned Power, the product also results in reduced fuel and oil consumption, while helping to increase engine life through reduction of friction.

CP also releases sticky valves and lifters and protects metal from carbon deposits, rust and corrosion.

Circle No. 9 on Reader Service Card

MULTI-PURPOSE LUBRICANT ANNOUNCED FOR TEXTILE INDUSTRY

A multi-purpose lubricant, developed by Quaker State Oil Refining Corp., Oil City, Pa., is said to have non-corrosive properties to all types of metals and alloys, and contains no soap-base thickening agents. The manufacturer states that the lubricating grease will not melt or drip at temperatures over 500 F. The lubricants advantages include adhesiveness to metal surfaces, heat stability, and moisture resistance. The product is produced for use in the lubrication of anti-friction bearings, plain bearings, and other types of mechanical parts requiring grease lubrication.

Circle No. 10 on Reader Service Card

LUBRICANT ADDITIVE AVAILABLE

Commercial availability of a new product, HYBASE M-300, is announced by Bryton Chemical Company. HYBASE M-300 is an oil-soluble magnesium sulfonate with a 300 base number. As such, it represents a new concept of solubilized metallic basicity and has application in lubricants requiring a high loading of metal in their formulations.

Two uses for HYBASE M-300 are as an additive for cylinder lubricants in marine diesel engines to reduce wear substantially and as a fuel additive to reduce vanadium corrosion, the announcement added.

Circle No. 11 on Reader Service Card

NEW ALKALINE RUST PREVENTIVE CLEANER INTRODUCED

Researched and developed within the Kerns United Laboratory, the new Alkaline Rust Preventive Cleaner, known as K-6882, is said to have excellent cleaning properties and also imparts an adequate film for rust protection. Further, it will not stain machined parts and is extremely easy to control.

Field test reports show it to be useful in shops utilizing alkaline power washer equipment to clean shop oils and shop dirt from parts which require storage prior to assembly or further machining operations.

Circle No. 12 on Reader Service Card

NEW FILTER DEVELOPED

A new process filtering equipment has been developed and manufactured by the Gelman Instrument Co., Chelsea, Mich., for filtering sub-micron particles from liquids. The disposable membrane filter unit is based on the use of a porous plastic sheet with uniform sub-micron holes in it and acts as a sieve to trap all particles of 0.1 micron and above in the filter. This membrane filter is housed in a metal container-support assembly and supported by a sintered stainless steel plate. The membrane filter portion is disposable. The filter holder is available in 3 different models for pressures of 50, 100 and 500 p.s.i.

Among the applications where this new process filter is expected to be of importance are: filtration of missile hydraulic fluids and fuels, and lubricants for precision bearings and gyro mechanisms requiring the complete exclusion of fine dirt particles. The membrane filter can be used to prepare lubricants free of all contamination.

Circle No. 13 on Reader Service Card

FIRE RESISTANT FLUID ANNOUNCED

Development of an economical water-glycol fluid that provides fire protection for industrial and military hydraulic systems has been announced by Celanese Chemical Company.

Known as Celluguard, the product has low temperature properties and is suited for use in low pressure hydraulic systems that do not require the heavy-duty properties of straight phosphate ester fluids like the Celanese Cellulube series.

The fluid's high water content is said to provide maximum fire resistance, and at the same time, Celluguard has good load-carrying ability and protects against vapor and liquid phase corrosion.

The new fluid is recommended for system applications in the range of 20-140 F., and offers properties as specified in MIL-H-22072 for fire-resistant, water-containing hydraulic fluids.

Circle No. 14 on Reader Service Card

CANTILEVER TYPE THRUST BEARING

Designed to reduce bearing failures caused by lack of squareness between shaft and housing components, this new type of bearing features an ability to withstand deflection loading.

Bearing plates are finished on one side for applying the load to the roller assembly. The stepped construction requires thicker plates than usual to carry the deflection loading and this thickness is calculated so that the working surfaces of the plates are maintained parallel where the rollers contact. Crowned rollers reduce end stresses between the rollers and thrust plates to provide increased thrust capacity.

Advantages of the new design result in reduced size of shaft forgings and housing castings, lowered tolerances in shaft and housing machine requirements, and improved bearing life.

Circle No. 15 on Reader Service Card

(Continued on page 149)

Better Greases Through BAROID RESEARCH

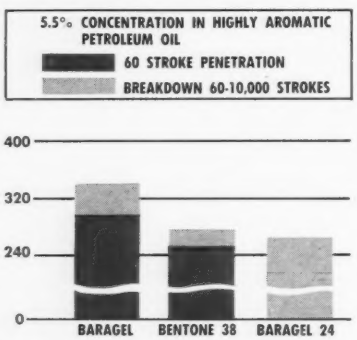
BARAGEL* 24 stabilizes greases made from petroleum oils

LABORATORY REPORT

BARAGEL* 24 in grease made from high aromatic oil

In a particular petroleum oil of high aromatic content (28%), BARAGEL 24 produced a grease completely stable to working in the ASTM grease worker over the range of unworked to 10,000 strokes.

In a series of tests, the oil used had an API gravity of 16.9° at 60° F and a viscosity of 309 SUS at 100° F. The worked penetration was 265 when

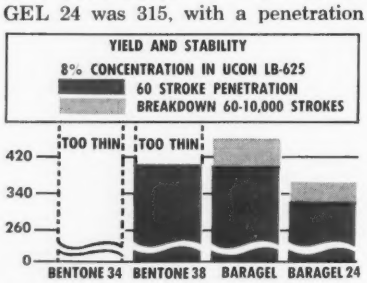


5.5% BARAGEL 24 was used. Comparisons of penetration when using the same percent of BENTONE* 34 and BARAGEL* are shown on the accompanying chart. Write to Baroid Chemicals, Inc. for Data Sheet A-4 which gives full details.

BARAGEL* 24 efficient thickener in greases made with Ucon LB-625

BARAGEL 24 is more efficient in thickening Ucon LB-625 than are BENTONE 34, BENTONE* 38 and BARAGEL. BARAGEL 24 greases are also more stable to working in the ASTM grease worker.

In a series of tests, the gelling agents were stirred into the Ucon LB-625, propylene carbonate was added, heat applied, and the mixture was milled. The chart below compares the results of thickening greases with BENTONE 34, BENTONE 38, BARAGEL and BARAGEL 24. The worked penetration of a grease made from Ucon LB-625 and 8% BARAGEL 24 was 315, with a penetration



of 355 after working 10,000 strokes. Full test details are available in Data Sheet A-1. Write Baroid Chemicals, Inc.

*Trademark of National Lead Company for an organic ammonium montmorillonite.

BAROID

BAROID CHEMICALS, INC.

A SUBSIDIARY OF NATIONAL LEAD COMPANY — 1809 SOUTH COAST BLDG. • HOUSTON 2, TEXAS

NEW PRODUCTS

(*Continued from page* 147)

NEW MODEL HI-PRESSURE SHUTOFF VALVES AVAILABLE

A companion model has been added to the 900 Series Hi-pressure Shutoff Valves produced by Circle Seal Products Co., Inc., Pasadena, California. The new 920-T Series Shutoff Valve is rated to 6000 psi operating pressure in liquid or gaseous service. Constructed entirely of stainless steel with Teflon seals, it is intended for use where corrosive conditions are exceptionally severe.

The 920-T Series Valve need not be removed from the line for replacement of the Teflon seals for maintenance. The stem threads are completely removed from the flow path to permit 'lifetime' lubrication and to prevent any possibility of the flow being contaminated by the lubricant. The double tapered stem design provides gradual throttling when the valve is closed.

Circle No. 16 on Reader Service Card

FLOW RATE COMPARATOR ANNOUNCED

Simmonds Precision Products, Inc., Tarrytown, New York, announces the design and development of a Flow Rate Comparator of laboratory standard quality. This instrument is designed to compare, calibrate and check accuracy of liquid flowmeters including orifice, rotameter and turbine types. The basic flow rate comparator unit is simplified, economical and easy to operate. Designed to work with a range of liquid flow rates from 0-800 lb/hr., the basic unit requires an external electronic counter for a time-readout device. The flow rate comparator can be used without removing a flowmeter from its installation. The flow comparator operates on a dynamic weighing principle; it electronically times the flow of a known weight of liquid. Overall accuracy is + 0.25% sensitivity is 0.0215%. Flow rate comparator is inertia compensated.

Circle No. 17 on Reader Service Card

NEW MULTI-PURPOSE LUBRICANT ANNOUNCED

B-F Molylubricants, a new line of multi-purpose lubricants, has been developed by the Chemical Products Division of Bridgeport Fabrics, Inc., Bridgeport, Conn.

The B-F "Molylubricants" consist of a complete line of molylubricant grease and oils, yet the manufacturer states that three of these products will take care of 90% of all plant lubrication applications.

Made with molybdenum disulphide, B-F "Molylubricants" are said to be stable under temperature ranges from minus fifteen degrees to plus four hundred and fifty degrees, and they will not molt under intense heat and are unaffected by freezing. B-F lubricants are claimed to be unaffected by salt water and most acids and alkalis.

Because of their low coefficient of friction and because they act as a solid film lubricant, B-F Molylubricants decrease machine wear and cut costly "down-time". B-F Molylubricants will not emulsify with water, are able to take pressures up to 150,000 psi. and prevent rust and corrosion.

Circle No. 18 on Reader Service Card

ANALYZER REPORTS ON OPERATING BEARINGS

The TEBA II (Tann Electric Bearing Analyzer) is said to be the first analyzer ever designed to directly determine and plot curves of the coefficient of friction versus the parameter zN/p. It also is said to be the first system to measure only the torque in test bearings while electronically eliminating the torque produced by the test mechanism.

The new analyzer was developed by Tann Bearing Co., Div. of Tann Corp., Detroit, Michigan to improve performance and establish higher standards for sleeve and shaft bearings.

TEBA II enables engineers to determine the effects of design changes on bearing operations, including such factors as material selection and surface finish, types of lubricant, and variations in length to diameter ratios.

Circle No. 19 on Reader Service Card

NEW OPEN GEAR LOOB INTRODUCED

Spray Products Corporation, Camden, N. J., announces the availability of Spray Open Gear Loob.

Spray Open Gear Loob was developed to protect open and exposed gears without the use of messy pails, brushes, paddles or grease guns. Spray Open Gear Loob will lubricate hard to reach areas quickly and easily without loss of lubricant. Developed for construction, farm and industrial applications, Spray Open Gear Loob protects gears from excessive wear, rust and the elements. For use on cranes, crushers, drills, grinders, mixers, presses, shovels, winches and all machinery and equipment where an open gear lubricant is required.

Circle No. 20 on Reader Service Card

NEW EQUIPMENT FOR HYDRAULIC OIL FILTERING

Hydraulic and other petroleum-based fluids and water can be filtered to absolute 3-micron cleanliness by means of the Triphane® filter assembly at rates up to 170 GPM continuous flow. No recirculation or preliminary filtration is required. The unit, developed originally for use in processing bulk MIL-H-5606 hydraulic oil before packaging, features high dirt capacity. It is a development of Aircraft Porous Media, Inc., a subsidiary of Pall Corporation, Glen Cove, N. Y.

The unit consists of a combination fiberglass membrane primary throw-away cartridge. The fiberglass is said to provide fine filtration coupled with large dirt capacity; the membrane removes particles larger than 3 microns and prevents migration. The primary cartridges are followed by the third stage Rigimesh® corrugated sintered woven wire mesh filter elements which provide 98% 5-micron filtration and absolute 18-micron filtration. The mesh elements protect the system during element changes and in the event the primary cartridges are damaged or omitted.

Circle No. 21 on Reader Service Card

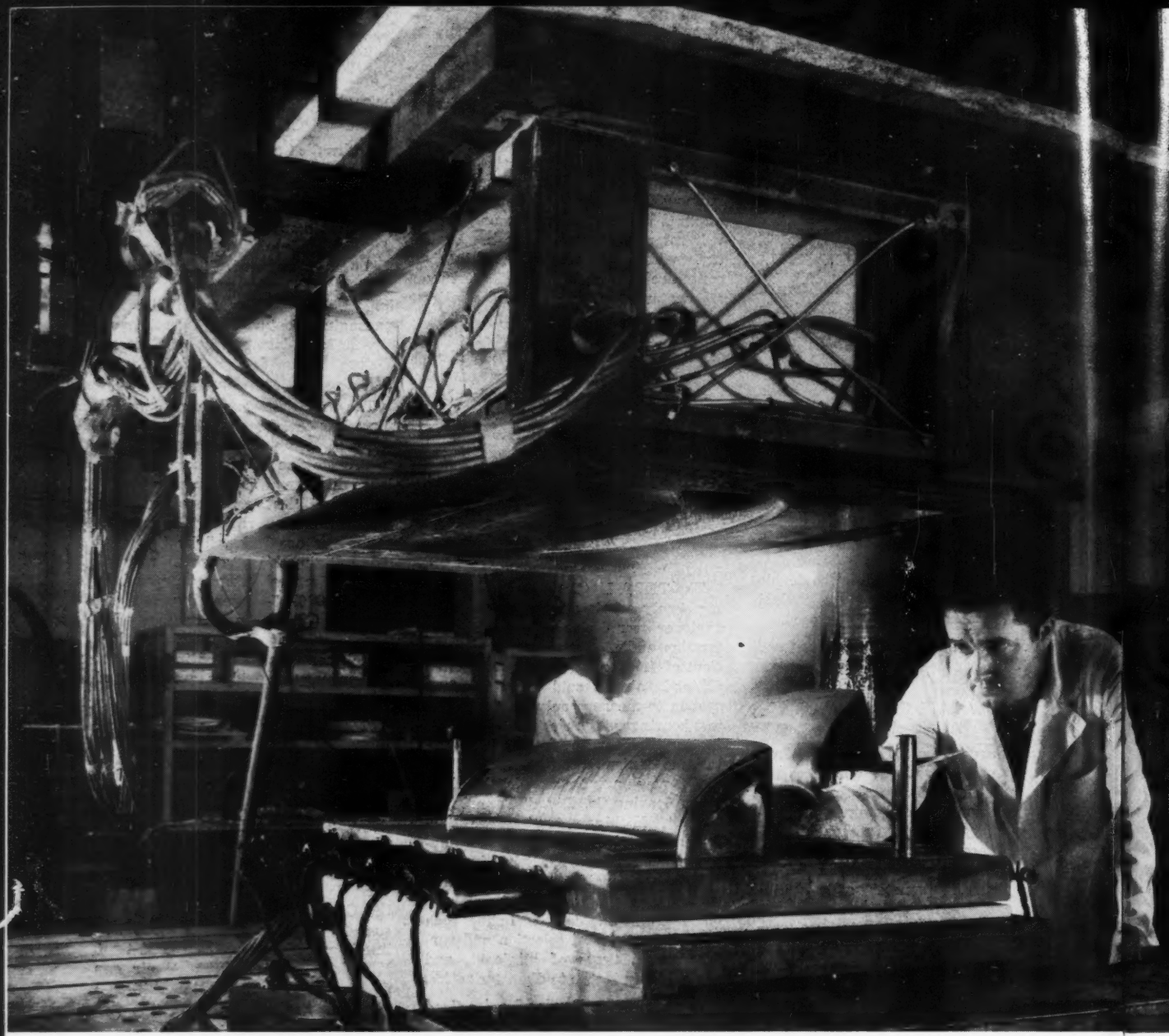
NEW SPEED VARIATOR AVAILABLE

Compactness has resulted by incorporating a motor with a mechanical variable speed drive, manufactured by the Cleveland Worm and Gear Division, Eaton Mfg. Company. The new line is available in sizes from ⅓ to 15 H.P. Motors are AC radial air gap design and conform to NEMA design "B" specifications.

Cleveland Speed Variator's design insures precise speed setting and repeatability. It provides variable output speeds with 9:1 and 6:1 ranges. Since it employs the rolling action of a series of balls, it permits smooth adjustment of the output speed while operating under load.

Power is transmitted through input shaft to a beveled drive disc in contact with axle-mounted alloy steel drive balls. Input shaft rotation causes balls to rotate about their axles, which in turn transmits power to the output shaft by a similar ball-disc contact. Output speed is determined by relative lengths of the contact paths on input and ouput sides of the balls. By tilting both axles and balls, relative lengths of the two contact paths are varied to give increasing or decreasing ratios.

Circle No. 22 on Reader Service Card

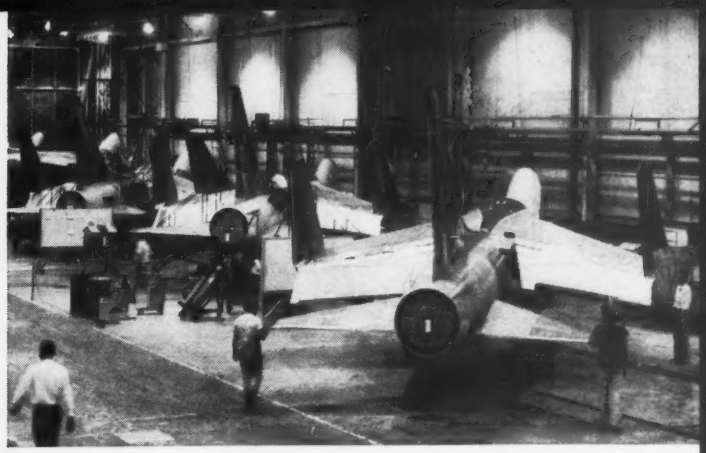


Gulf Harmony® oil has the extra stability press operation at Chance Vought...

Chance Vought Corporation, Dallas, Texas, developed a unique production technique to speed production of jet fighters. It's a 1000-ton press with electrically heated dies that permits the forming and stress-relieving of a titanium part in one operation.

However, this advanced technique created several problems. One, according to Doy Stanley, General Foreman, Facilities, was the heavier burden placed on operating parts of the press. When forming and stress-relieving were combined in one operation, high temperatures and pressures had to be applied for long periods of time. Under these conditions, maintenance of the press is very important. According to Mr. Stanley, "We've always stressed efficiency in our operation. And downtime is, as you might say, doubly inefficient."

Proper lubrication of hydraulic mechanisms and other press parts subjected to elevated temperatures and pressures is a must to keep production right on schedule. Says Mr. Stanley: "We have never had any



F8U Navy fighters near the end of the assembly line. Aircraft's leading edges use titanium part that has been formed and stress-relieved in one operation.

Doy Stanley, left, discusses hydraulic oil applications with Grover Garrison, Gulf Sales Engineer. Hamilton Press shown in background is one of various presses at Chance Vought that use Gulf Harmony oil.

On this 1000-ton press, simultaneous forming and stress relieving of titanium takes place at 1000 deg. F. Quality Gulf Harmony oil protects the vital hydraulic system.

needed for high temperature
GULF MAKES THINGS RUN BETTER!

downtime, or any trouble at all that can be attributed to lubrication. This excellent record is due mainly to the fact we use a high quality hydraulic oil that won't break down under heat."

That "high quality hydraulic oil" Mr. Stanley refers to is Gulf Harmony. It not only withstands heat, but resists oxidation, which improves service life and prevents sludge formation. Also, a corrosion inhibitor guards against rust, and an anti-foaming additive assures a smooth transfer of power.

If you have problems involving hydraulic fluids, or any petroleum product application, may we have the opportunity to prove to you that Gulf makes things run better! Call your nearest Gulf office, or write us for additional information.

GULF OIL CORPORATION
Dept. DM, Gulf Building
Houston 2, Texas

GULF

NOW!

Superior motor oils can be formulated with much lower ash content!

New Oronite 1200 Series Lubricating Oil Additives. Now you can have the desired diesel and high-temperature gasoline engine performance —PLUS—lowest combustion chamber deposits and less pre-ignition tendencies in low-temperature engine operation—with your oils compounded with years-ahead Oronite 1200 Series additives. Oronite's 1200 Series additives have been extensively checked in laboratory and field with spectacular results. They readily satisfy performance requirements of Caterpillar L-1 diesel tests, Supplement 1 conditions. These additives show excellent performance in AMA's MS Sequences, and inspection data from taxicab field tests confirm excellent low-temperature performance shown by lab tests.

Technical Bulletin!

Get the complete story—write for Oronite technical bulletin describing in detail the new 1200 Series additives. Address your inquiry to any Oronite office.

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6925

PRODUCT LITERATURE

The Society will not be responsible for the accuracy of statements made in this column. Any reference to proprietary products does not imply an endorsement of such products by the Society.

BULLETIN DESCRIBES ROTARY GEAR PUMPS

A new bulletin has been issued by Northern Ordnance Inc. of Minneapolis, Minn. on Northern Nitralloy Rotary Gear Pumps. The bulletin describes the range and capacities and lists the applications for the pumps.

Details are given on how Northern engineers individually process inquiries to select the proper pump size, materials and clearances, and offer standardized production techniques to keep the costs down.

Circle No. 23 on Reader Service Card

BROCHURE ON RULON(R) AND TEFLON PARTS OFFERED

A 4-page brochure describing the characteristics and qualities of Rulon and Teflon is available from the Plastics Div. of the Dixon Corp., Bristol, R. I. Brochure #9572 compares the electrical, physical, mechanical, and chemical properties of Rulon and Teflon. Rulon is a reinforced TFE fluorocarbon resin offering the advantages of Teflon—low friction, chemical inertness, zero moisture absorption, extreme temperature range—plus increased mechanical strength and wear resistance.

The brochure illustrates Dixon's Rulon parts made to meet customer requirements for lube-free bearings, O-rings, wear strips, valve seats, thrust washers, and other applications calling for low deformation under load, low coefficient of friction, and high compressive strength.

Circle No. 24 on Reader Service Card

DATA SHEET DESCRIBES NEW BONDED LUBRICANT COATING

The characteristics of MOLYKOTE PVE, a new bonded lubricant coating for ferrous surfaces, are described in a new data sheet published by The Alpha-Molykote Corporation. Originally compounded for use on cutting tools, the new molybdenum disulfide lubricant is also useful on heavily loaded ferrous bearing surfaces in all types of mechanisms.

In addition to giving full specifications for the new coating, the two-page, two-color bulletin includes data from actual tests of the material on metal cutting tools. The method of applying MOLYKOTE PVE is described and illustrated.

Circle No. 25 on Reader Service Card

LUBRICANTS FOR ALUMINUM-WORKING GUIDE PUBLISHED

"Lubricants for Aluminum-Working," a guide for the metal working industry, has been published by Reynolds Metals Company, Richmond, Va.

The 24-page booklet lists lubricants as recommended by 20 petroleum processors, and covers 19 metal working operations. Recommended lubricants are keyed to each of the operations, which include: blanking, bending, piercing, bulging, deep and shallow drawing, embossing, cold and hot extruding, cold and hot forging, hammer forming (metal punch), hammer forming (rubber punch), ironing, necking, roll forming, spinning, stretching and swaging.

Circle No. 26 on Reader Service Card

SURVEY ON LEADING THIOKOL LP BASE SEALANTS NOW AVAILABLE

A 24-page brochure containing test data on seven leading brands of Thiokol LP Base Sealants is available from the Building Products Division of Sonneborn Chemical and Refining Corporation, New York.

The survey, conducted by the National Testing Laboratories of New York, reveals that Thiokol LP Base Sealants differ markedly in their elastic properties and performance potential. These differences are primarily due to the use of various polymeric modifications, chemical additives, and compounding techniques.

Circle No. 27 on Reader Service Card

MINIATURE AND INSTRUMENT BEARING CATALOG RELEASED

The Fafnir Bearing Company of New Britain, Conn. has published an up-to-date miniature and instrument bearing catalog for industry. This 40-page catalog contains dimensional information as well as the practical engineering and application data required to service this highly specialized field. It offers all the data necessary for the selection and specification of ball bearings for modern instruments. A feature of this catalog is the picturing of bearings actual size. This catalog provides designers with the opportunity to select the types and sizes of ball bearings which offer practical and economical solutions to their application problems.

Circle No. 28 on Reader Service Card

NEW LITERATURE ON PUMPS AND ACCESSORIES AVAILABLE

A condensed catalog of high vacuum components and equipment manufactured by NRC Equipment Corporation has been published.

The 8-page catalog summarizes the complete NRC line of high vacuum mechanical and diffusion pumps, valves, gauges, accessories, portable pumping systems, coaters, furnaces, electron beam welders, altitude chambers and freeze drying equipment.

Circle No. 29 on Reader Service Card

SPECIFICATION CATALOG ISSUED

The Bray Oil Company announces the release of its Mil-Spec Catalog. The list carries references on over 450 specifications, and has been found valuable by many users of specification products in the fields of lubrication, hydraulics, corrosion prevention, and similar specialized areas.

In addition to the numerous references for current specifications, the list gives the Military Specification equivalent for approximately 300 Aeronautical (AN-), Air Force, Army, Navy, SAE and Aerospace manufacturers specifications.

Also available, by special request, is a list of ninety NATO Symbols and the equivalent U.S. Specifications.

Circle No. 30 on Reader Service Card

BALL VALVE LITERATURE PUBLISHED

The new Lunkenheimer Ball Valve is described and detailed in a two-page, two-color catalog sheet by the Lunkenheimer Co., of Cincinnati, Ohio. The bulletin, Circular 611, details the operation of the valve, shows cutaway views, ratings, describes specific design features and dimensions, reports on applications and advantages.

Circle No. 31 on Reader Service Card

Panel Members at the January 12 Pittsburgh Section Meeting. Subject—"Industrial Lubricants." Left to right: Mike M. Gurgo, E. S. Reynolds, J. D. Lykens, and L. B. Sargent, Jr.

EFFICIENT • RELIABLE • ECONOMICAL

McCORD MODEL F GREASE LUBRICATOR

Machine tool, press, turbine, hoist, crusher, conveyor, you name it . . . if it requires greasing, *automate* with McCord's Model F Grease Lubricator. You'll cut labor costs, prevent work stoppages, minimize maintenance and repairs, reduce lubricant consumption.

Yes, McCord's Model F is fully automatic and features individually controlled feed that positively, accurately delivers the *right* quantity of grease to each individual point . . . regardless of grease weight, pressures or coldest weather. You can *count* on it, because McCord Grease Lubricator design and construction is the result of more than 30 years of field experience.

Available with rotary drive, 22.5:1 or 45:1, and ratchet drive, 1.5:1 or 2.5:1. Capacities, 4-16 quarts.

For full particulars on McCord's Model F, write today to: Advertising Manager—

McCORD CORPORATION

Lubricator Division • Detroit 11, Michigan

Northern California—The Northern California Section will sponsor a one-day Practical Lubrication Course on May 10, 1961. The course is geared to give the man in the field a basic knowledge of lubrication and a respect for what correct lubrication can accomplish.
A brief outline of the day's program is as follows:

8:30—I. Lubricating Oils
II. Greases
10:00—Coffee Break
10:15—III. Lubrication of Sleeve Bearings
IV. Lubrication of Antifriction Bearings
12:15—Lunch
1:15—V. Lubrication of Gears
1:45—VI. Lubricant Dispensing Equipment
2:15—VII. Hydraulics
3:15—Coffee Break
3:30—VIII. Presentation of U. S. Steel Lubrication Engineers Manual
4:00—Final Questions.

Registration fees, which will include materials, luncheon, and coffee breaks, are $5.00 for ASLE members and $10.00 for non-members.
For further information or application blanks, please contact: Mr. G. H. Hommer, Research and Development Department, Tidewater Oil Company, Martinez, Calif.

Cleveland—"Know Your Motor Oil" will be discussed by a speaker from Du-Pont Corp. at the April 25, 1961 meeting.

Philadelphia—Past Chairman's Night was observed at the March 16, 1961 meeting when Mr. H. William Weaver, Ingersoll-Rand Co., presented a paper entitled "Keeping the Pressure Up."

Chicago—Guest Night will be observed at the May 18, 1961 meeting when Mr. E. J. Krabacher, The Cincinnati Milling Machine Co., Cincinnati, Ohio, will talk on "What's Required and What's New in Cutting Fluids."

Saginaw Valley—A representative from Acheson Industries, Inc. will speak on the subject, "New Developments in Hi Temperature Lubes," at May 25 meeting.

Montreal—"Trends in Lubrication Requirements" will be the subject discussed by Mr. A. B. Wilder, E. I. Du-pont de Nemours, at the May 3, 1961 meeting.

(*Continued on page* 155)

LETTERS TO THE EDITOR

Lubrication Engineering welcomes comments and suggestions of readers with regard to articles published in its pages or concerning topics of interest to those engaged in any phase of lubrication engineering. Letters received cannot be acknowledged, but those felt to be of interest to other readers will be published. The Society will not be responsible for the statements or opinions expressed.

Sir:

Please refer to the paper by A. Cameron, "A Theory of Boundary Lubrication", ASLE *Transactions*, Vol. 2, No. 2, p. 195.

Cameron's hypothesis that friction in boundary lubrication can be attributed principally to forces between adsorbed molecules, and only secondarily to welding and shearing of high spots, is appealing. The argument is clearly and forcefully presented; and, further, he comes up with a reasonable answer.

It would be helpful to clarify a few points which we find troublesome. It is shown that motion of a single adsorbed polar molecule on one surface, relative to a layer of similar adsorbed molecules on the opposite surface, moves the molecule from a position of low energy level, E_1, to a higher level, E_2, and then back to the low level, E_1, as the next atom is approached. The attractive and repulsive forces related to changes from E_1 to E_2 are analyzed. No consideration is given, however, to the part played by the return to the energy state E_1 from E_2, which should, it seems, be equal and opposite. The treatment of Cameron would seem to require a continuous supply of energy to move molecules to the positions of least attraction, with no consideration of the work done in the return to equilibrium positions. If the return were not important, as soon as all the molecules were at the E_2 level, should not the frictional force have reached a relatively low level? Such an effect, if it were reasonable, might explain the difference between static and kinetic friction.

The assumption of complete surface contact seems highly idealized. The argument that pressures equal to the yield stress will produce complete surface contact, without roughness, fails to consider the effect of work hardening on yield strength of metals, and evidence that complete contact is not observed. (Bowden and Tabor, "The Friction and Lubrication of Solids", Oxford 1950, p. 31, 223.) If the frictional force calculated for the areas which form contacts, some very small fraction of the nominal area, is compared with normal pressures of 40-120 tons/in.^{2}, the ratio F/P appears to be the same very small fraction of the observed coefficients of friction.

If we have misinterpreted, or failed to comprehend the discussion, comment by Dr. Cameron would be welcome.

Yours very truly,
Harold J. Dawe,
Research Director
Acheson Industries, Inc.

Sir:

At last I am replying to the most interesting letter you sent me from Acheson Industries, Inc. dated November 2. Would you be kind enough to forward this letter or a copy of it to them and thank them for their trouble in writing. I would be very willing to reply further to any subsequent queries they might like to raise.

In reply to their first question about the work done in the return to the equilibrium position, the short answer is that it is postulated that all this energy is dissipated as heat. There is a certain amount of support for this view. The arguments are the same as postulating that the value of E_2 is small compared to E_1. If all the energy was returned, a molecule would be able to skid about on the surface without let or hindrance. Müller in his work on paraffins found that the evaporation energy was additive with each $-CH_2$ group. If the two energies were similar in size it would be possible to pull a paraffin chain out lengthwise, rather like pulling a bamboo cane out of a bundle, independently of the number of CH_2 groups in the chain. This is not the case and hence both Müller and myself assume that neither the energy is returned nor that the positions of maximum and minimum energy are associated with attractions of similar magnitude.

The second paragraph deals with the assumption that the normal stress equals the yield stress of the metal. Firstly of course, the yield stress is the yield stress *including* work hardening. Secondly, it does not matter whether complete contact is observed or not. It would seem that providing the actual area of contact is given by load/actual yield stress the theory holds. Whether this area equals the geometrical nominal contact area or not is irrelevant. In those cases where there is external contact such as a ball on a plane it can be shown experimentally that this law is approximately true.

Yours sincerely,
A. Cameron

SECTION NEWS

(*Continued from page* 154)

Hudson-Mohawk—Mr. E. Brown, General Electric Company, is scheduled to speak at the May 23, 1961 meeting. His subject will be, "Advances in High Temperature Lubricants."

The Cleveland Section observed "National Officers Night" at the January 24, 1961 meeting. Left to right: L. O. Witzenburg (Cleveland Worm and Gear Co.), ASLE President; Howard Peeples (Timken Roller Bearing Co.), ASLE Director; and George Smith (C. H. Clark Oil Co.), Program Chairman.

VADEN
VANISOUL

New Epoch making Additive in the preparation of Water-Soluble Grinding Fluid.

By adding 1% in volume of VADEN VANISOUL to water, a splendid grinding fluid, excellent both in anti-rust and machining capacities, will be produced.

This fluid guarantees the most precise and cleanest finish to the metal work surfaces, while improving the grinding efficiency.

(For further Technical Literature please apply to us)

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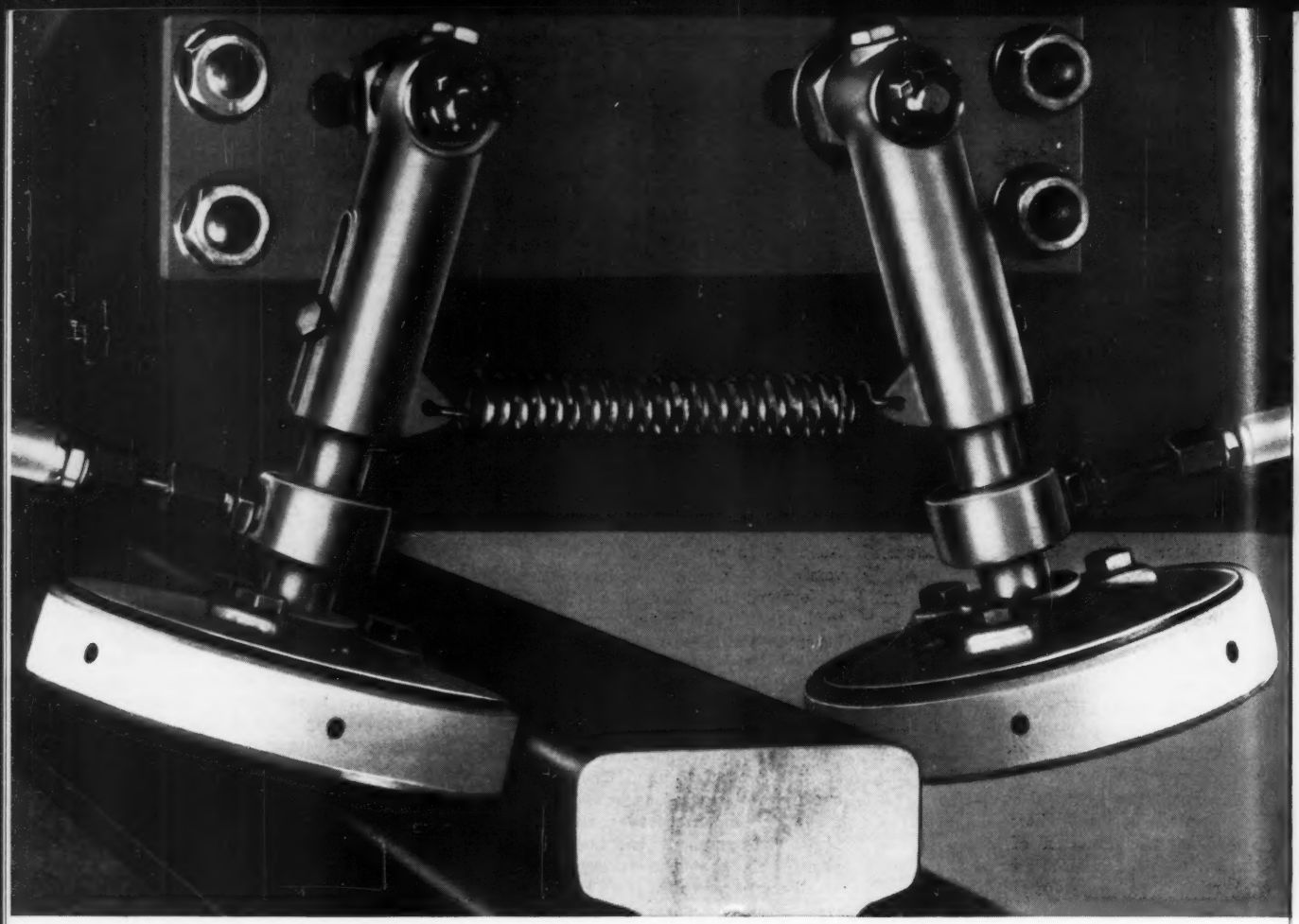
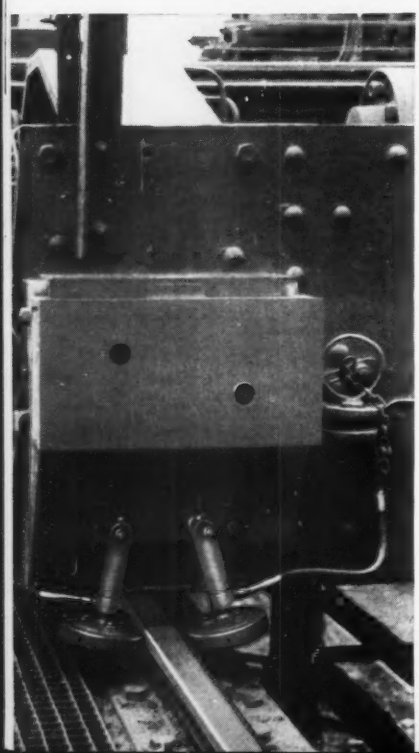


NEW CRANE RAIL LUBRICATOR

adds 31 months to wheel life on 135-ton crane

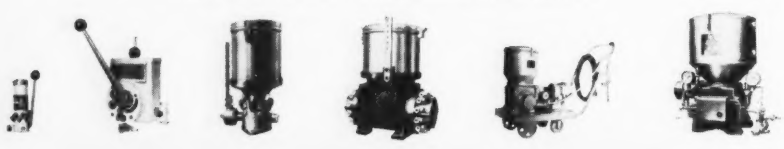


Prior to installation of a DeLimon Single Crane Rail Lubrication system, maintenance records on this overhead crane showed down time for wheel change *once every four months.* Today, wheel changes are made only after 35 months continuous service! In addition, the rate of wear on rails has been reduced approximately 20 per cent.

Engineered and built to give positive, trouble-free lubrication, the system operates from a pump actuated by the long travel shaft of the crane. Felt roller pads on applicators mounted on either side of the rail leave a minute film of lubricant as they travel. Available as single and double systems, the lubricator can be used on any size of crane or rail.

WRITE FOR FREE BULLETIN on the new Crane Rail Lubricator. Engineering assistance in centralized lubricating of hydraulic, mechanical, electric motorized and pneumatic equipment also available on request —address: Research Appliance Company, Lubrication Division, P. O. Box 307C, Allison Park, Pa.

FOR ALL TYPES OF CENTRALIZED LUBRICATION



RESEARCH APPLIANCE COMPANY

Lubrication Division

P. O. Box 307C, Allison Park, Pa.

Exclusive Agents for DeLimon in the United States and Canada

SOCIETY NEWS

APPOINTED ASLE EXECUTIVE SECRETARY

DONALD B. SANBERG

The Society announces the appointment of Mr. Donald B. Sanberg as Executive Secretary of ASLE to become effective May 1, 1961 with the resignation of C. L. Willey.

A native of Minnesota, Don went through the Minneapolis Public School system, and started his college career at the University of Minnesota in 1949. A little over a year later, the Korean emergency intervened, and college was delayed for three years while he served in the Army.

Don was sent to the Army Language School and subsequently served the rest of his hitch as a translator in Washington, D. C. Discharged with the rank of sergeant in 1954, he returned to the University of Minnesota for his degree in Business Administration.

While completing his education, Don started his career in association management with the American Collectors Association as a part-time employee. When he left this group, he was in charge of direct mail activities and statistics.

Don joined the Malleable Founders Society in 1957 as Administrative Director. His duties there included office administration, purchasing, personnel, meeting arrangements, and serving as secretary of several committees. A new group within this association was formed in 1958, called the Malleable Castings Council, to carry on a $200,000 advertising program promoting malleable iron castings. Don took on the additional duties of Advertising Director of the Council, and has managed three years' campaigns for the group.

NEW ASLE MEMBERS JANUARY, 1961

CHICAGO

James L. Andrew
The Pure Oil Company
Palatine, Illinois

John R. Condon, Jr.
Commercial Filters Corp.
Chicago, Illinois

John R. Grimley
Celanese Chemical Co.
Niles, Illinois

Bruce J. Holmberg (R)
Mobil Oil Company
Cicero, Illinois

Joseph Tomko
Metal Lubricants Company
Chicago, Illinois

CLEVELAND

Peter J. Ghirla
The Lubrizol Corporation
Cleveland, Ohio

Arthur D. Schwope
Clevite
Cleveland, Ohio

PITTSBURGH

R. J. McCloskey
Geo. P. Dempler Company
Pittsburgh, Pennsylvania

Thomas G. Olsen
The Pure Oil Company
Pittsburgh, Pennsylvania

LOS ANGELES

O. A. Norton
Autonetics Div. of
North American Aviation
Compton, California

Howard A. Peterson (R)
Texaco, Incorporated
Los Angeles, California

NEW YORK

Thomas J. Conroy
Gruman Aircraft Eng. Corp.
Bethpage, New York

Luther D. Dromgold
Kendall Refining Company
Bradford, Pennsylvania

Theodore C. Larson
California Oil Company
East Orange, New Jersey

Peter C. Meyer
Sun Oil Company
Newark, New Jersey

W. E. Rettig
California Oil Company
Perth Amboy, New Jersey

PHILADELPHIA

Allen E. Bryson
The Atlantic Refining Co.
Philadelphia, Pennsylvania

James F. Nicholas
Arguto Oilless Bearing Co.
Philadelphia, Pennsylvania

NORTHERN CALIFORNIA

H. B. DeBenedetti
Tidewater Oil Company
Martinez, California

(*Continued on page* 158)

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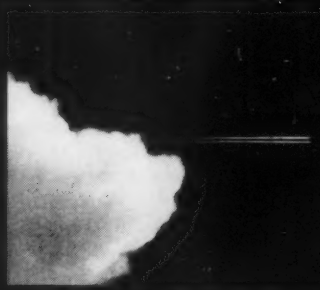

BOEING
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SOCIETY NEWS

(*Continued from page* 157)

BOSTON
John A. Bjork
Morgan Construction Co.
Worcester, Massachusetts

CONNECTICUT
Jacque L. Wilson
Inland Graphite & Chemical Co.
Bridgeport, Connecticut

FORT WAYNE
Dean V. Wills
Standard Oil, Div. American Oil Company
Fort Wayne, Indiana

YOUNGSTOWN
Paul W. Dietzel
Standard Oil Company (Ohio)
Youngstown, Ohio

CINCINNATI
Paul F. Thompson
Carlisle Chemical Works, Inc.
Reading, Ohio

KANSAS CITY
Oscar C. Moon
The Bendix Corporation
Kansas City, Missouri

TORONTO
W. J. Kribs
Cities Service Oil Co. Ltd.
Toronto, Ontario, Canada

MONTREAL
Chesley E. Petite
Canadian Oil Companies Ltd.
Montreal, Que., Canada

HOUSTON
Charles A. Falkenhagen, Jr.
Tennessee Gas Pipeline Co.
Houston, Texas

Jan L. Ivey
Union Carbide Chemical Co.
Texas City, Texas

John B. Williams
Bay Petroleum Corporation
Houston, Texas

OKLAHOMA
Robert G. Dye
Luttrell Oil Company
Tulsa, Oklahoma

UNAFILLIATED
Carroll A. Meader
Highway Equipment Company
Spokane, Washington

FOREIGN
G. V. Natarajan
Bhilai Steel Plant
Madhya, Pradesh, India

NEW ASLE MEMBERS FEBRUARY, 1961

CHICAGO
I. T. Fritz
Sinclair Refining Co.
Harvey, Illinois

MILWAUKEE
Carl E. Kolda
Allis-Chalmers
West Allis, Wisconsin

LOS ANGELES
Jas. S. Bassett
Union Oil Co. of Calif.
Great Falls, Montana

NEW YORK
Patrick Joseph Keating, Jr.
Texaco, Incorporated
Beacon, New York

Fred Krupin
General Aniline & Film Corp.
New York, New York

Joseph A. McGroarty
Merck & Company, Inc.
Rahway, New Jersey

PHILADELPHIA
William T. Rambo
Standard Pressed Steel Co.
Jenkintown, Pennsylvania

BUFFALO
Howard R. Mellor (R)
Mobil Oil Company, Inc.
Buffalo, New York

DETROIT
William C. Morgan
Pen Petroleum Corporation
Detroit, Michigan

BOSTON
Ernest H. Scott
United Shoe Machinery Corp.
Beverly, Mass.

CONNECTICUT
James R. Mitchell
Farrel Birmingham Co., Inc.
Ansonia, Connecticut

Carl A. Swanson
Esso Standard
New Haven, Connecticut

CINCINNATI
Stephen John Jacobs
Acheson Colloids
Cincinnati, Ohio

Robert T. Trites
Emery Industries, Inc.
Cincinnati, Ohio

TORONTO
William Blokhuis
New Surpass Petrochemicals Ltd.
Scarborough, Ontario, Canada

MONTREAL
John Wyllie
Stone Franklin of Canada Ltd.
Montreal, Quebec, Canada

OKLAHOMA
Glenn E. Holman
Phillips Petroleum Co.
Bartlesville, Oklahoma

UNAFFILIATED
Clyde P. Holland
Mobil Oil Company
Nashville, Tennessee

FOREIGN
Bertold Sprenger
Siemag Siegener Maschinenbau
Siegen, Germany

*Reinstated

ASLE National Award Winner

DR. WILLIAM A. ZISMAN

Dr. William A. Zisman, Superintendent of the Naval Research Laboratory, has been designated as recipient of the ASLE National Award. This award is made by the American Society of Lubrication Engineers in recognition of outstanding contributions to lubrication engineering or allied fields.

Dr. Zisman has had a distinguished career which encompasses a wide range of both fundamental and applied science. His publications and studies in the field of lubrication have been both numerous and substantial. He pioneered the development and widespread use of synthetic lubricants and greases and was also responsible for the development of aqueous-base fire resistant hydraulic fluids. His investigations on the relation of the structure of lubricating fluids to such properties as viscosity, viscosity-temperature coefficient, liquidus range, volatility, stability, and boundary lubricating properties have been widely applied and are now considered classic in the lubrication field.

The outstanding characteristic of Dr. Zisman's many contributions has been the manner in which he has been able to bring fundamental scientific considerations to bear on the solution of practical lubrication problems. Typical of this approach was the development by Dr. Zisman and his group of an all-weather lubricating system for aircraft machine guns during the Korean War. This work was done and completed on a rush schedule, and the resulting lubricant was utilized on a large scale. Another example of the practical approach was the development of water-glycol base fire resistant hydraulic fluids. This development was based on fundamental considerations that led to products which are now widely used by the plant lubrication engineer.

Dr. Zisman's work has by no means been confined to the field of lubrication. He is well known for his fundamental work in surface and colloid chemistry. His many studies and publications have dealt with surface potentials of monolayers and multilayers, contact potentials, the spreading of oils on water, oleophobic monolayers, and adsorption at the oil/solid and water/solid interfaces. They also include studies of the wetting of surfaces by pure liquids and solutions; of surface activity at the interface between organic liquids and air; and of frictional phenomena as related to surface constitution and the presence of adsorbed monolayers. He has also been responsible for the development of several widely used experimental techniques in the field of surface chemistry. The award will be presented at the ASLE Banquet at the time of the Annual Meeting.

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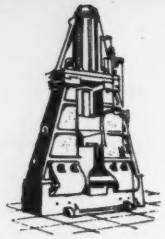
announcing the EUROPEAN ASLE STUDY TRIP

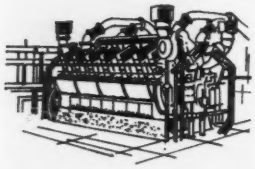
Interested in learning the latest European lubrication techniques? Want to know what's happening in lubricant research and development on the Continent? Curious about bearings, centralized systems, greases, or rolling oils used in the steel plants of England and West Germany? Then join the ASLE Study Group. Take the tour that will provide you with the answers first-hand . . . from European Lubrication Engineers.

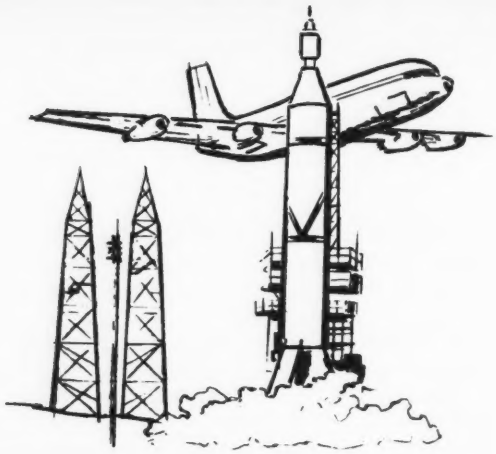
The American Society of Lubrication Engineers is sponsoring a study trip to Europe in July 1961. This trip has been arranged in cooperation with the Institute of Petroleum in England and the Verein Deutscher Eisenhuttenleute of West Germany. Due to the ASLE's interest in lubricants and steel plant lubrication, the purpose of the trip is two-fold; first, it will afford the opportunity to study the latest trends in European research and development and second, the trip will acquaint men of American industries with the lubrication techniques practiced in European steel making plants.

Two countres—England and Germany—will be visited by the study group. The entire tour will last twenty-seven days including the days of departure and arrival in New York. For those who cannot visit both England and Germany, arrangements can be made to visit either country. The number of personnel that can participate is limited. Membership in the ASLE is not required of participants. Complete itinerary will be published in the May issue. But don't wait—since space and time is limited.

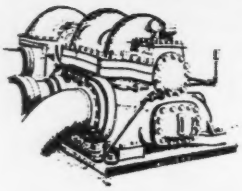
For further details contact: W. L. Roberts, Applied Research Laboratory, United States Steel Corporation, Monroeville, Pennsylvania.

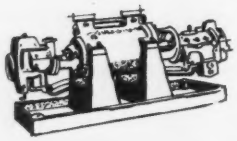


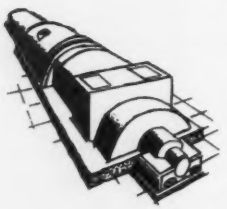




Status Report—
Multi-Purpose Lubricants







Editor's Note—

STATUS REPORT—MULTI-PURPOSE LUBRICANTS is the first of a series of articles in various areas of general interest to lubrication engineers. Subjects have been selected on the basis of the reader preference survey conducted last fall.

In preparing these articles, your editorial board has been fortunate in securing the cooperation of nationally recognized authorities in various fields of lubrication research and engineering. Each article will comprise their comment in response to specific key questions on the subject under discussion.

J. Boyd

commentary by

Lowrie B. Sargent, Jr.
Chief, Lubricants Division
Alcoa Research Laboratories
Aluminum Company
of America
New Kensington, Pa.

Dr. Sargent completed his doctorate in physical chemistry at Pennsylvania State University and has been a member of the lubricants division of the Alcoa Research Laboratories since 1942. He is a director of ASLE and past chairman of the society's Pittsburgh section.

John R. Belt*
Fuels and Lubricants Division
Chemistry Department
U. S. Naval Engineering
Experiment Station
Annapolis, Md.

Mr. Belt has been active in the U. S. Naval Engineering Experiment Station since 1946, following a term of active service and a degree in chemical engineering from Johns Hopkins University. His division is the "headquarters" lab for all shipboard application of lubricants.

Drop the phrase *Multi-Purpose Lubricants* into any quiet gathering of lubrication engineers and you're certain to get a first order reaction—for several reasons. First, true multi-purpose lubricants are generally recognized as holding great promise for the improvement and modernization of lubrication practices.

Second, there is a great deal of general misconception concerning the nature, application and availability of multi-purpose lubricants. Third, these materials, either actual or hypothetical, are the subject of widespread interest and curiosity.

Here are the facts, in the form of response to key questions put to Dr. Lowrie B. Sargent, Jr. and John R. Belt, both recognized authorities on the subject.

Question: What Is a Multi-Purpose Lubricant?

Answer: First, to clear up one of the most common fallacies in this connection, a multi-purpose lubricant is *not* an *all-purpose* lubricant. Such a material would necessarily fall into the same category as perpetual motion, universal solvents and the philosopher's touchstone.

By definition, a multi-purpose lubricant is a lubricating material that combines the capabilities or special properties of two or more conventional lubricants. Conversely, a multi-purpose lubricant is one that will perform satisfactorily in two or more applications normally requiring different lubricants.

This latter description is probably the most correct because it implies the practical advantage of multi-purpose lubricants more clearly. When considered on the basis of special properties alone, there is hardly a lubricating material in use today that does not combine a number of special properties to some degree. Yet, they are not considered multi-purpose lubricants.

Moreover, the definition of a multi-purpose lubricant as one that will perform in two or more applications normally requiring different lubricants actually fits the facts as they exist. At present, on the basis of formulation specifically for multi-purpose use, there are no multi-purpose lubricants.

Practically, however, many users are of necessity making certain materials serve several dis-similar applications. These applications, based on compromising ideal specifications and theories, actually make the materials in use quasi multi-purpose lubricants. A true multi-purpose lubricant would, of course, meet such needs better than the materials now being "stretched" to cover the job.

**The opinions expressed by the author are personal and are not to be construed as official nor do they reflect the views of the Department of the Navy or of the naval service at large.*

It must be pointed out, incidentally, that the above applies primarily to fluid lubricants. Multi-purpose greases, thanks to the new lithium and calcium complex bases, are already in wide use and more than 90% of the grease requirements of almost any operation can be satisfied with a single grease.

Therefore, this discussion of multi-purpose lubricants will deal primarily with fluid lubricants—this is where the problem and uncertainty exists. As to processing oils, they also stand apart in a separate classification.

In summary, then, a multi-purpose lubricant is an oil that will perform efficiently in two or more applications normally requiring different lubricating materials.

Question: Is This a New Concept in Lubrication Engineering?

Answer: No. Serious, and in some cases urgent, interest in the development and application of multi-purpose lubricants goes back at least 40 years. After the first World War, it became immediately apparent to the military, especially to the Navy, that multi-purpose lubricants were absolutely essential.

It was in the first World War that the problem of operating complex machinery in widely scattered parts of the world first emerged. And with it came the staggering logistic difficulty of keeping this machinery supplied with the required fuels and lubricants. Quite obviously, keeping supply bases thousands of miles away stocked with an endless variety of special purpose materials was impractical.

Shortly afterward, industrial concern with the inherent economies of multi-purpose lubricants began to grow. These economies involve handling, use and quantity procurement or production rather than initial cost—a true multi-purpose lubricant would probably be more costly than the materials now in use from a purchasing standpoint.

Then, World War II turned what had been low-pressure interest into a real drive. This drive has been one of the most important factors in the recent growth in stature of lubrication engineering because lubrication engineering has produced the most significant results to date in the quest for a multi-purpose lubricant—simply by putting existing lubricants to multi-purpose use. Relatively little work has actually been done in the formulation and production of materials fundamentally intended for multi-purpose use.

The practical engineering approach, however, has resulted in great progress. Through careful specification and application, even involving basic equipment design in many cases, the number of different lubricants required for a typical piece of production equipment has been reduced by about half.

Question: How Would a True Multi-Purpose Lubricant Differ From Those in Current Use?

Answer: Primarily in degree. The basic properties of all lubricants, whether they be special or multi-purpose, are fairly well defined now as far as performance is concerned . . . viscosity index, rust and oxidation inhibition, emulsibility, load carrying capacity, thermal stability and friction or wear reducing capabilities are among the most common . . . and most lubricants now in use possess several of these properties in some combination.

A true multi-purpose lubricant would, in essence, simply go a step farther and feature more complex combinations of properties, each in a higher degree. Thus, one possible multi-purpose lubricant might combine the E. P. properties of a gear oil, the R & O inhibition of a turbine oil and offer a viscosity range suitable for hydraulic system use.

But the process is not as simple as it might sound. Consider, for instance, trying to combine the detergency of a crank case oil with the low emulsibility desired in a good turbine oil.

To answer the question another way, one of the biggest differences between the lubricants in use today and a true multi-purpose lubricant might well be simply in a lack of knowledge of how to apply lubricants. With advancement in basic understanding of how the lubricants we now have work, and where they can be applied, we will certainly be closer to a multi-purpose lubricant type of system.

In short, there is no sharp dividing line between conventional lubricants now in use and a theoretical multi-purpose lubricant. Rather, the concept of multi-purpose lubricants represents a goal that we can work toward by means of advancements in practice as well as in petroleum or synthetic chemistry. But like so many goals, it will probably never be reached, only approached.

Question: Are Multi-Purpose Lubricants Commercially Available?

Answer: No, not as such. The development trend in lubricant production has been mainly concerned with materials to meet the increasingly *extreme* requirements of modern technology. This is contrary to the development of a multi-purpose material to meet *diverse* requirements.

However, many commercially available oils can and are being used to a certain extent as multi-purpose materials. This practice usually involves selecting a lubricant that will meet the most severe requirement in a group of applications and then using this better than necessary material in other places. Obviously, when this is done, the economies of handling and quantity procurement must offset the cost differential between the lubricant used and several other cheaper but adequate lubricants.

Also, as mentioned before, commercially available materials probably have a great deal more multi-purpose capability than is now being utilized. Thus, better engineering as well as new chemistry will take us closer to the goal of true multi-purpose lubricants.

Question: What Are Some Typical Immediate Uses for Multi-Purpose Lubricants?

Answer: An answer to this question will have to be theoretical, but it will help define what is really meant by a multi-purpose lubricant. Remember, even among really effective materials of this type, there will be differences.

One example of how a multi-purpose lubricant could be used to great advantage would be in the form of a turbine oil with high load carrying capacity to make

it suitable for gear lubrication use. Actually, this combination of applications is common and is being serviced with a single material in some cases at present. But a compromise is being made. No material that combines the properties of the best turbine oils with those of the best gear oils exists.

Another desirable multi-purpose lubricant would be a fire resistant gear and bearing oil suitable for hydraulic system use. These applications exist side by side in much production equipment today, and contamination and safety problems would be greatly reduced if the same material met both needs. The equipment itself could be simplified, too.

Naval shipboard practices highlight the immediacy of the need for multi-purpose lubricants because, of necessity, they must use what they have aboard as if it were a true multi-purpose lubricant. Turbine oils, for instance, are used in great quantities in large surface ships and are made to cover the majority of all other lubricating needs in such vessels. Aboard submarines, diesel engine crankcase oils are similarly pressed into use for pumps, compressors, drives and bearing lubrication.

Question: What Would the General Advantages of True Multi-Purpose Lubricants Be?

Answer: The general advantages underlying the increasingly urgent demand for true multi-purpose lubricants are both economic and operational. On the economic side, production and procurement in larger quantities would almost certainly result in lower first costs.

Storage and inventory costs would also be reduced through basic simplification of the systems and procedures involved. Then, to these direct economic gains must be added the indirect economies that would accrue as the result of the operational or practical advantages of a true multi-purpose lubricant. These would quite probably exceed the direct economies in dollar importance.

Greatly simplified application procedures, with only one or two different lubricants satisfying all of the requirements of a complex industrial operation (or an entire ship) comprise one of the greatest of the operational advantages of multi-purpose lubricants. The chance for human error would be tremendously reduced if not eliminated, as would the need for careful specification and designation of the materials to be used in specific items of equipment.

Equipment breakdown or failure incidence would be similarly decreased. Fewer errors in lubricant application would work in this direction, of course, and there would also be less need to compromise on desired lubricant properties if a material were available that combined a wider range of the desired properties.

Another consideration would be the decreased danger of lubricant contamination due to inadvertent mixing of incompatible materials. This mixing is a very real problem where two or three such materials are used in the same machine or even kept in the same storage area. There is no large plant in operation today without its own history of cases where thousands of gallons of costly lubricants or hydraulic fluids have been ruined by a simple and understandable error in using the wrong material as a make-up charge.

Lubricant supply problems, both the small ones involving an annoying shortage of a given material in a manufacturing plant and the big ones encountered in keeping supply bases adequately stocked all over the world, would also tend to disappear. From the plant viewpoint, there is almost no danger of running out of a single material stocked and used in large quantities throughout the operation. From the global supply or logistic viewpoint, as encountered in Naval operations, the problem would be reduced from the critical one of maintaining a full catalog of materials to the simple one of making sure that a tanker made its rounds. Lubricant inventories could be surveyed on a "yes or no" basis in contrast to complex, bulky reports.

Thus, true multi-purpose lubricants could be expected to reduce both procurement and over-all operating costs in addition to improving and protecting equipment operation to a greater degree than is now practical with a multiplicity of so-called single purpose lubricants.

Question: What Is the Probable Short Term Future in Multi-Purpose Lubricants?

Answer: The actual need for multi-purpose lubricants is reaching the critical stage. Equipment is growing more complicated every day and the problem of providing good or even adequate lubrication with more and more specialized materials is approaching the point of impracticality.

In response to this pressure, new materials can be expected to appear on the market. However, as the over-all picture looks now in lubricant material research and development, there is no dramatic breakthrough in sight. Barring some tremendous and unforeseen discovery, new materials will provide only a small part of the short-term solution to the problems that make multi-purpose lubricants so urgently needed.

The most important gains that will be made in the near future will be of a practical nature. Engineers in the field, as their knowledge of lubricants now available increases, will gradually extend the range of application of existing materials. New equipment, also, will be designed to fall within this range.

An interesting battle, if you will, is shaping up right now between the increasingly complex lubricant requirements of modern equipment on the one side and the need to meet these requirements with as few different materials as possible on the other. The gains to be made by improvements in lubrication engineering technique will probably just about offset the new requirements that are cropping up—to "hold the line" against increased lubrication complexity for the near future.

As a matter of fact, some programs are actually intended to do just this, as in the Navy. For some years now, despite a literal flood of new requirements, the *number* of different standard materials in use in the fleet has not increased—although the materials themselves have changed considerably.

For the near future, advancement toward the ultimate advantages implied by multi-purpose lubricants will be much more along the lines of improved techniques of application and engineering than in the development of new materials.

Question: Will Multi-Purpose Lubricants Introduce New Problems?

Answer: Not significantly. Naturally, there will be some changes from the general procedures and practices with which we are familiar today. But these changes should not be real problems.

The increased quantities of a single lubricant material to be handled, as opposed to the smaller quantities of several materials now handled, will be the greatest change. Continuous production instead of batch production and procurement in tank car or truck quantities will become more common.

And with these larger production and procurement quantities, larger volume storage facilities will be required. Then, depending on the relation of rate of use to the quantities stored, time of retention in stock will vary. In some cases, multi-purpose lubricants will be held in storage for longer periods of time than the material now in use—making stability and "shelf-life" an important corollary characteristic of multi-purpose lubricants.

In other cases, where the use of multi-purpose material to meet a wider range of applications results in rapid consumption, stock turnover will be fast, and time of retention correspondingly short. As a matter of fact, a fast turnover situation of this type would actually permit the use of relatively small storage facilities, simply substituting a regular system of deliveries for storage capacity.

Regardless of the quantities stored, or the speed of turnover, however, inventory control and dispensing procedures will be inevitably simplified.

Question: Will Multi-Purpose Lubricants Require Basic Changes in Lubrication Engineering Practices?

Answer: As far as the fundamental objectives of lubrication engineering are concerned, there will be no change—merely greater facility in achieving these objectives. A great many of the frustrations that now confront a lubrication engineer will disappear.

There will, however, be some changes in certain phases of lubrication engineering. Storage and handling, for instance, as just mentioned, will call for a new approach. Two other specific practices fairly common in the field will also have to be re-evaluated.

These are the practices of altering or "doctoring" available materials on an individual preference basis and the reconstituting or reclaiming of used lubricants. Because new multi-purpose lubricants will certainly be more complex chemically than the oils now in use, field changes in their formulation are quite likely to impair or even destroy their effectiveness.

Even with the fairly straightforward formulations in use today, changes of as little as .1% in certain critical additives can cause wide fluctuations in performance. And increased chemical complexity will also change the reclaiming picture.

Where certain materials can be re-used now after simple filtering, and even restored to an approximation of original effectiveness by the introduction of additive replacements, new multi-purpose lubricants will probably be too subtle in their formulation to permit simple field manipulation. On the other hand, with greater stability, multi-purpose lubricants will greatly reduce the economic necessity for reclaiming by lasting much longer in use. Periodic make-up rather than replacement will be the rule with the ultimate multi-purpose lubricants.

Question: What Is the "State of the Art" in Multi-Purpose Lubricants?

Answer: Most arts or techniques follow about the same pattern in their development. First, the need emerges. Then the art is conceived and devised to meet the need. Finally, the application of the art is refined to become a part of the body of scientific knowledge and engineering procedure.

Our present application of special purpose lubricants is an example of an art that has followed this development sequence.

In multi-purpose lubricants, step one is about complete. The need is immediate, urgent and well recognized. Work is just beginning on step two.

The chemical solution to the problem has not yet been worked out, nor does such a development seem imminent. But significant progress has been and is being made in developing the practical and engineering aspects of the art.

Lubrication engineers are making increased multi-purpose use of existing lubricants and equipment designers are striving to simplify rather than to extend special purpose lubricant requirements wherever possible. This progress represents definite development in the art and has been enough to hold lubricant specialization at a constant level while actual requirements have grown rapidly more complex in recent years.

But how long this practical approach will suffice is the really important question today. It is doubtful that the art of multi-purpose lubricants and their application can develop much further than it has to date without definite stimulation in the form of new materials. Even "holding the line" on a strictly practical basis is becoming more and more difficult.

Thus, a reasonable evaluation of the state of the art would probably place it in a very critical stage. The need is established and the art has developed to a point where fundamentally new materials are required to lift the practice of lubrication engineering onto a new plateau—the third stage of the art.

Failing this, the art of multi-purpose lubricants and their application will go only as far as our present practical approach can take it. Then, the urgency of the need for some answer to the growing problems imposed by our current trend toward lubricant specialization will force some completely different solution.

(If you have further questions on some *general* aspect of multi-purpose lubricants not covered here, your editorial board will be happy to review them in future columns. Naturally, because the entire concept of multi-purpose is theoretical at this time, specifics are not available)

Performance of

EP GEAR LUBRICANTS

in the rear axles of an over-the-road truck fleet

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Three rear axle lubricants—two of MIL-L-2105 quality, one of MIL-L-002105A (ORD) quality—were tested in a commercial truck fleet to determine their effect on axle performance. Test operation length was approximately 18 months during which time some trucks accumulated as much as 90,000 miles.

The three test lubricants had no effect on the frequency of axle failures which resulted from fatigue of the gear contact surfaces or distress in gearing and bearings caused by circulation of foreign particles in the oil.

Laboratory endurance tests were conducted according to conditions outlined by the axle manufacturer using the same axle and two of the same lubricants as were used in the fleet tests. Neither lubricant tested gave a satisfactory result, therefore no lubricant comparison is drawn on the basis of the laboratory dynamometer test.

INTRODUCTION

During the past two years a great deal of interest has centered about the comparative performance of gear lubricants in truck service.

The need for gear lubricants which would satisfy higher performance requirements, their development, testing in the laboratory and field, and commercial application have been discussed in technical literature. Previous experience with MIL-L-002105A (ORD) lubricants in commercial fleet tests had shown that long, trouble-free, service life was to be expected as shown by Fig. 1. However, information to the contrary has been presented (3) indicating that these oils might be deficient in load-carrying capacity.

This paper presents results obtained to date from a truck fleet which was instituted to determine the over-the-road axle performance of three chemically different rear axle lubricants. This specific fleet was pointed out by a major truck axle manufacturer as one which had indicated weakness in load-carrying quality in GL-4 lubricants. Two of the three lubricants tested under these conditions were of MIL-L-2105 quality and one of MIL-L-002105A (ORD) quality. In addition, laboratory endurance tests were conducted using the same axle and two of the same lubricants as were used in fleet trucks.

Fig. 1. Erie, Pennsylvania, Freight Fleet, Spiral Bevel, 2 Speed Axle, 19,000 lb Rating 151,872 miles. MIL-L-002105A (ORD) Lubricant.

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April, 1960

COMMERCIAL FLEET BACKGROUND

Equipment used for this test is owned by a freight line which operates in Michigan, Ohio, Indiana and Illinois. Operation is generally over flat land, and much use is made of available toll roads and expressways. The trucks are dispatched from and maintained at a central terminal in Toledo, Ohio. Cargo is dry freight —auto parts, canned foodstuffs, drugs, building materials, furniture, hardware, etc.—which means that loading is non-uniform from trip to trip averaging 47,800 lbs gross combination weight. Trailers range in length from 32 to 38 feet.

Nineteen tractors from this fleet were used in this test program. All are of the cab-over-engine type with 401 cu. in. V-8 engines, 8-speed transmissions and single rear axles. Axles are single reduction, spiral bevel type, 6.5 to 1 ratio, with straddle mounted pinion. An oil collector tube rides against the ring gear to collect oil and feed the pinion bearings. General layout provides for full floating axle shafts in a banjo type housing into which the differential head assembly is mounted, and a stamped rear cover which is sealed with a cork gasket and held by cap screws. The manufacturer lists the capacity at 21,000 lbs for normal service.

Routine maintenance schedule specified a 40,000-mile drain for rear axle lubricant. Axle lubricant level was checked at the 2,000-mile chassis lubrication interval. All lubrication and mechanical work on rear axles was done in the terminal garage with the exception of removing and installing new ring gears when required. The ring gear is riveted to the differential case and this portion of an axle rebuild job was "farmed out" to a local service branch of the truck manufacturer.

Prior to initiation of our test program, the fleet was using a lubricant represented to be GL-4 type. Axle service life ranged from 16,000 to 150,000 miles as shown in Fig. 2. Bearing replacements were made in six axles at mileages ranging from 17,000 to 96,000 miles and sixteen axles were completely rebuilt—new ring gear, pinion and bearings—between 16,000 and 127,000 miles.

Fig. 2. Axle Maintenance—Original Equipment Toledo Fleet. Maintenance Record (25 Trucks).

Severe distress in pinion and ring gear contact surfaces was commonplace and was often, although not always, accompanied by bearing distress. An example of the type of failure experienced in a typical axle is shown in Figs. 3 and 4. In truck number 2683 all bear-

Fig. 3. Toledo Fleet, Truck 2683—109,449 Miles. Original Unit.

Fig. 4. Toledo Fleet, Truck 2676—29,896 Miles. Rebuilt Unit.

ings appeared to be serviceable; in truck number 2676 both the rear pinion bearing and straddle mount bearing were in very poor condition, but gear condition is similarly bad in both.

Axle shaft breakage was a major problem and still is, as will be shown later. Seal leakage had been quite a problem, but it lessened when a change in the type of speed-governing mechanism was made. According to the terminal manager, the elimination of engine speed surging alleviated seal difficulty.

It is clear from the above that service life of the units varied considerably. Since all of the vehicles had operated with the same lubricant it was not possible to ascertain whether the low mileage failures were due to the lubricant or to the combination of axle and type of service involved. The Author's test program was initiated to determine whether the early failures could be eliminated when other lubricants were used.

TEST LUBRICANTS

Choice of lubricants was made to include factory fill and recommended field service type as well as a lubricant of the type suspected by the axle manufacturer to be low in load-carrying capacity. SAE 90 grade was used throughout the program. These are listed in Table 1.

TABLE 1.—Test Lubricants

TYPE	PERFORMANCE LEVEL	TEST AXLE MANUFACTURERS' RECOMMENDATIONS
Sulphur, Chlorine, Lead (SCL)	MIL-L-2105	Factory Fill and Field Service
Sulphur, Chlorine, Phosphorus (SCP)	MIL-L-2105	Field Service
Sulphur, Chlorine, Phosphorus, Zinc (SCPZ)	MIL-L-002105A (ORD) (for GL-4 service)	Not Recommended

TEST PROGRAM

Differential head assemblies were purchased from the original equipment manufacturer and were installed as received from the factory. This was done to eliminate any variables that might arise when axles are rebuilt in the shop. Axle housings were cleaned to remove traces of previous lubricant and dirt or metal chips. Head assemblies and rear axle covers were color coded to match lubricant drums. Axles were serviced with test lubricant and the trucks were then dispatched to regular operation.

Lubricant change interval was designated as 40,000 miles with the stipulation that this interval would depend on the condition of drain samples taken periodically. There was no intent to change the lubricant drain interval or mechanical maintenance procedures from previous practice except where continuation of these would obliterate information pertinent to the test program. For instance, a broken axle shaft occurring on the road away from the maintenance terminal was generally replaced at the most convenient service facility. This involved removing the broken shaft and cleaning chips from the housing, installing a new shaft and servicing the axle with an available lubricant. During the test program it was necessary to require a change back to the test lubricant as soon as the truck returned to the maintenance terminal.

Operation of the vehicles was left to the demands of commercial carrier practice. No attempt was made to equalize mileage. Controls were applied only to the selection and supply of lubricants, preparation of test axles, specification of lubricant drain interval and disassembly and inspection of axles.

ACCIDENTAL FAILURES

During the operation of this test fleet (approximately 18 months) a number of accidental failures occurred. These were not the typical failures which prompted a lubricant test in this fleet, but discussion is necessary since they reduce the total number of axles on test by about 14% and the number of axles on one lubricant by nearly 30%.

Failure A
21,534 Miles
MIL-L-2105
(SCP)
— Stub end of a broken axle shaft ran between the ring and pinion breaking teeth in both.

Failure B
36,753 Miles
MIL-L-002105A (ORD)
(SCPZ)
— 45% water contamination in axle lubricant. Ring and pinion contact surfaces severely scored and discolored by both heat and rust. Bearings corroded and discolored by rust. This truck was in service during the Winter '59 when floods were widespread in Northern Ohio, and it is suspected that the rear axle was submerged in flood water.

Failure C
40,447 Miles
MIL-L-2105
(SCL)
— Axle shaft broke splitting the differential case and damaging the left carrier bearing. Ring and pinion were not damaged. Repaired and continued on test.

Failure D
59,705 Miles
MIL-L-002105A (ORD)
(SCPZ)
— Front universal joint broke while truck was in motion letting front end of drive shaft strike the ground. Resultant jar damaged pinion shaft seal. After a hasty repair to the universal joint, further service resulted in loss of lubricant. Pinion and ring gear were ridged and pinion bearings were loosened.

Notice that failures A and C above involve damage from broken axle shafts. This was a constant problem throughout the test, and, in addition to varying the lubricant change interval, may have shortened axle life because of the metal particles that are generally liberated when this shattering type fracture occurs. In all, eleven axle shafts have been broken and replaced in nineteen trucks during eighteen months, operation.

Failure B described above prompted an analysis of the lubricant in all axles for water content. It was found that four contained from 0.5% to 3.5% water, and a change was prescribed for these. The 40,000-mile drain interval was approaching on other units, some of which contained 0.2% water. These latter were kept on a routine schedule for drain and refill.

AXLE INSPECTION

All test axles were inspected at an intermediate point in an effort to avoid analysis of so-called "basket cases" such as shown in Fig. 4. This was an effective plan since it permitted recognition of localized distress before failure became so severe that its cause could not be determined. Test head assemblies were removed from the trucks and were replaced with spare units. This allowed the fleet operator to continue normal operation and afforded our laboratory personnel ample time for careful disassembly, inspection, photographing and reassembly of serviceable units. When the reassembled test axle was again installed in the truck, it was serviced with fresh lubricant.

FLEET—TEST RESULTS

Failures found during inspection show distress similar to that experienced prior to this test program and these occur on all three lubricants. The results are summarized in Table 2. Inspections were made at mileages ranging from 35,000 to 80,000 miles.

TABLE 2.—Test Fleet Status

LUBRICANT CODE	NO. OF AXLES STARTED ON TEST	NO. OF ACCIDENTAL FAILURES*	NO. OF TYPICAL FAILURES	NO. OF AXLES IN SERVICE
MIL-L-2105 (SCL)	6	0	2	4
MIL-L-2105 (SCP)	8	1	1	6
MIL-L-002105A (ORD) (SCPZ)	7	2	1	4

*Failures resulting in loss of test head assembly.

ANALYSIS OF TYPICAL FAILURES

On the MIL-L-2105 (SCL) lubricant, heavy fatigue is apparent on the pinion at 52,906 miles. This is shown in Fig. 5. Carrier and pinion bearings show no

Fig. 5. Toledo Fleet, Truck 2673—52,906 Miles. Lubricant: MIL-L-2105 (SCL).

distress other than heavy indentations from foreign particles. Heavy wear is evident on the oil collector tube. Another failure on this same lubricant at 36,943 miles was not discovered as promptly and resulted in more extensive damage to all axle parts.

A series of defects was found during inspection of axle parts from a truck running on MIL-L-2105 (SCP) lubricant for 50,156 miles. The pinion shows a small area where seizure and welding has occurred. Very light ridging and rippling are evident as well as heavy face scratches. Pinion bearings show some distress and fatigue is evident on the outer race of the left carrier bearing. It is believed that a pinching effect on the carrier bearing outer race caused by the cap which clamps this bearing in place may have caused the distressed area shown in Fig. 6. It is believed that the seizure and welding and face scratching found on the pinion and the distress in pinion bearings may be a direct result of large metal particles being worn from the oil collector tube, shown in Fig. 7, and then circulated through bearings and between gear tooth contact surfaces. The non-uniform bearing contact pattern evident in Fig. 6 has been found in all of the left carrier bearings. Further study would be required to determine what effect this might have on bearing life or on the condition of the gears.

After 56,547 miles of operation on MIL-L-002105A (ORD) (SCPZ) lubricant, one axle failed due to heavy fatigue at the root of the tooth on the drive side of the pinion. This is similar to the failure observed in Fig. 5 with the SCL lubricant. Ridging runs from the fatigued area at the root out to the crest of the tooth. There is a well defined wear ridge at the toe end of the pinion near the root extending down and becoming

less pronounced near the center of the tooth. This type distress is also plainly evident on the ring gear. This unusual contact pattern in the gears points to misalignment between the ring and pinion.

A thorough investigation into the possible cause of misalignment between the ring and pinion is not within the scope of this paper. However, observation of the axle parts from this test program indicate that deflection of the differential case when torque loads are high could be of major importance. There is evidence in some instances of movement between the case halves causing heavy galling of the metal on the parting surface. This has been observed in over 50% of the axles on test.

The differential case is made up of two halves fastened together to form a beam of circular cross section resting in the carrier bearings at the ends and supporting the ring gear in the correct location with relation to the pinion. It is suspected that under high torque loading the differential case may deflect enough to allow the contact pattern between ring and pinion to shift and develop high stress inviting fatigue.

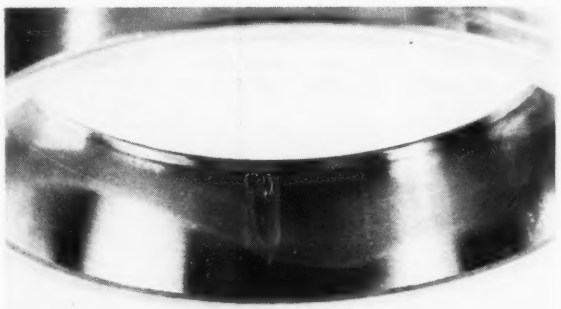

Fig. 6. Left Carrier Bearing, Toledo Fleet, Truck 2691—50,156 Miles. Lubricant: MIL-L-2105 (SCP).

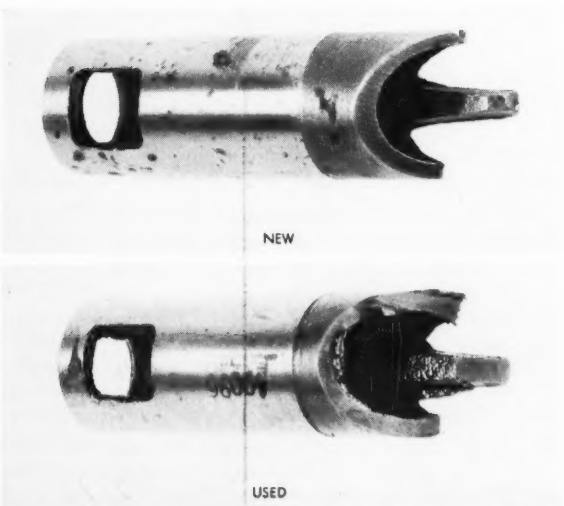

Fig. 7. Oil Collector Tubes, Toledo Fleet, Truck 2691—50,156 Miles. Lubricant: MIL-L-2105 (SCP).

RUST AND CORROSION

The only corrosion found in this fleet occurred in bearings. In one axle operated on MIL-L-002105A (ORD) (SCPZ) lubricant, red rust was evident on the end of the carrier bearing outer races. Rust does not appear on the contact area of these or other bearings or parts in the axle. Drain data show that water contamination was 0.5% at 20,415 miles at which time the lubricant was changed. Etching was found in the carrier bearings of three axles on MIL-L-2105 (SCL) lubricant as shown in Fig. 8. Since this occurs in the load-carrying contact area, it might contribute to short bearing life. No evidence of corrosion was found in other parts of these three axles. Water contamination varied between a trace and 0.2% maximum in these axles and no lubricant drains were made to remove this amount of water.

Fig. 8. Carrier Bearings, Toledo Fleet, Truck 2694—64,485 Miles. Lubricant: MIL-L-2105 (SCL).

INSPECTION OF AXLES STILL IN SERVICE

Pinions in axles which remain in service are generally polished smoothly with some indication of foreign particles having circulated between the contact faces. A large number, however, have a line of small cavities formed in the metal surface near the edge of the contact pattern at the root of the tooth. This has been described by various axle and lubricant authorities as "hair-line pitting," "interference line" or "baseline fatigue." It is suspected that this small area may progress until conditions such as occurred in the failure of the MIL-L-2105 (SCL) or MIL-L-002105A (ORD) (SCPZ) lubricant develops. Intermediate inspection of axles which exhibit this condition is the only plausible way to determine if this is true. Distribution of this phenomena, as shown in Table 3 indicates that it is not influenced by difference in type of lubricant.

TABLE 3.—Distribution of Pinion Fatigue

TYPE	NO. OF AXLES IN SERVICE	NO. OF PINIONS WITH FATIGUE AT BASELINE
MIL-L-2105 (SCL)	4	2
MIL-L-2105 (SCP)	6	3
MIL-L-002105A (SCPZ)	4	3

When it is considered, however, that all 8 axles which show fatigue at the base of the pinion tooth also have galling of the differential parting surface, and 5 of the 6 axles which are free from fatigue in the pinion have no significant amount of distress at the differential parting surface, it is concluded that correlation between these two may exist. The one axle which does not fit this analysis is free from fatigue at the pinion baseline even though galling on the differential case indicates movement between the two halves. Such a variation in observation of the fatigue phenomena is not unusual.

Fig. 9 shows a pinion which has a visible area affected by fatigue at the baseline. Notice that there is no ridging or scoring in the pinion tooth contact area which would be expected if the lubricant lacked load-carrying capacity and that deposits are almost non-existent. The differential case from this same axle has heavy galling at the parting surface as shown in Fig. 10. The major portion of deposits found in the axles inspected is inside the differential case, and, it may be seen in Fig. 10 that sludge is very light. Wear on the oil collector tube is very heavy and has caused formation of metal chips on the inside of the tube. Pinion bearings and carrier bearings show no unusual condtions other than an uneven contact path in the left carrier bearing.

Up to the time of inspection, no seal leakage was encountered on any of the lubricants except in the case where direct mechanical damage was the cause.

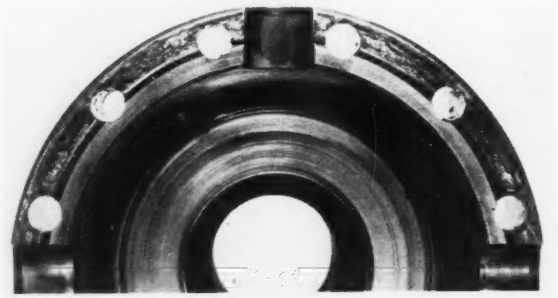

Fig. 10. Differential Case, Toledo Fleet, Truck 2678—56,917 Miles. Lubricant: MIL-L-002105A (ORD) (SCPZ)

Fig. 9. Toledo Fleet, Truck 2678—56,917 Miles. Lubricant: MIL-L-002105A (ORD) (SCPZ).

SUMMARY OF FLEET TEST EXPERIENCE

Premature axle failures occur on all three lubricants tested and to about the same degree. On the basis of these tests it is believed that performance of all three lubricants was equivalent and that early failures were typical for the combination of axle and type of service employed in this fleet.

GENERAL TEST DATA

Operating Temperatures. This item was investigated to determine if there was a significant difference in the three oils with reference to the axle bulk oil temperature under normal operating conditions. It was also of interest to know the level of temperature developed and to speculate on whether such temperature could contribute to excessive lubricant deterioration.

Fig. 11 shows the temperature chart for MIL-L-2105 (SCL) and MIL-L-002105A (ORD) (SCPZ) lubricant operating in the same axle, over the same route and carrying similar loads. Maximum temperatures of 168F and 161F, respectively, were obtained when operating at turnpike speeds. During the return trip over State and Federal Highways, which are

mostly two lanes passing through several cities, maximum temperature is 153F for both lubricants. Temperature records for the MIL-L-2105 (SCP) lubricant obtained on State and Federal Highways with a comparable gross load indicate a maximum temperature of 148F compared with 153F for the other two lubricants.

These temperature records indicate little difference in the three lubricants as far as operating temperatures are concerned, and, as drain data will verify, the level of operating temperature is not high enough to cuase oil oxidation to any great extent.

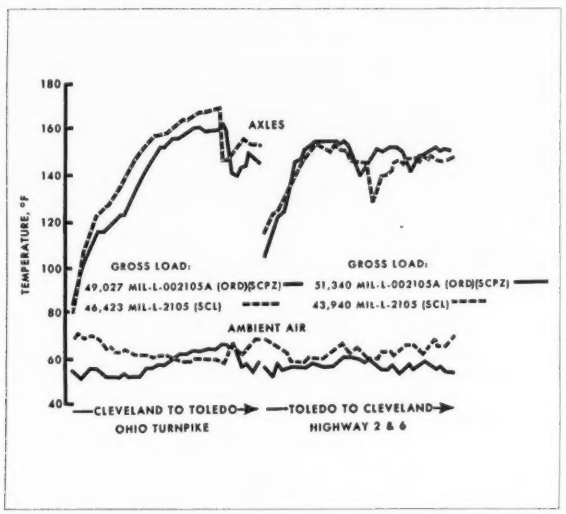

Fig. 11. Rear Axle Bulk Oil Temperature, Toledo Fleet.

LUBRICANT DRAIN DATA

The results of analysis of oils which had been in use for 35,000 to 40,000 miles are shown in Table 4.

The oxidation rate as measured by pentane insolubles and viscosity increase is low as shown in Table 4. It is believed that this is a reflection of the relatively low operating temperature.

The general trend observed during the operation of this fleet is that water contamination is below 0.2%, often 0, with the exception of the few cases cited previously. It was also observed that water contamination does not necessarily build up in ever-increasing amounts; some samples showed a decrease in per cent water contamination with increasing mileage.

Emission spectrographic analysis for active elements shows no significant depletion of extreme pressure agents in any of the three lubricants on test.

TABLE 4.—Drain Analysis

RANGE OF CHARACTERISTICS IN SAMPLE IN USE 35,000 TO 40,000 MILES	MIL-L-2105 (SCL)	MIL-L-2105 (SCP)	MIL-L-002105A (ORD) (SCPZ)
% Pentane Insolubles	4.1 -4.4	0.1 -0.5	0.4 -0.6
% Viscosity Increases, 210 F	3.5 -7.5	1.2 -4.4	1.8 -6.2
% Iron*	0.03-0.17	0.03-0.15	0.05-0.08

*Emission spectrographic analyses.

LABORATORY ENDURANCE TESTING

These endurance tests were conducted to obtain additional information on the performance of the identical axles and lubricants used in the fleet tests. Work in this area was done with the MIL-L-2105 (SCL) and MIL-L-002105A (ORD) (SCPZ) lubricants only, since they represent the greatest difference in both chemical composition and performance level. Tests were conducted according to the conditions outlined by R. K. Nelson. (3) Briefly, those conditions are as follows:

A. Break-In Loads
   - 1 Hour — No load
   - 1 Hour — ¼ load—3250 lb/ft torque
   - 1 Hour — ½ load—6500 lb/ft torque
   - 1 Hour — ¾ load—9750 lb/ft torque

B. Test Load
   Continuous operation at 13,000 lb/ft torque —9,710 lb/in of face.

C. Axle Speed
   75 RPM under all conditions above

The results from four tests on each of two lubricants are summarized in Table 5. A satisfactory tooth condition was not obtained in any of the eight tests. Ridging of the pinion surface was found in all cases except one, and can occur during the break-in where the torque applied is only ¾ of rated load. Wear on the oil collector tube is very heavy after only four hours' operation. Ridging after a maximum number of test cycles at full load is somewhat heavier and is accompanied by fatigue in the same area of the pinion as that developed in the fleet test results. Distress was found in the rollers and cone of the rear pinion bearing on four of the tests. Tooth breakage occurred in two of the tests and indicates that the test loads are near the limit of mechanical strength of the gear teeth.

It appears that these laboratory test results correlate with the Toledo fleet test to the extent that there is no difference in the performance of the lubricants tested.

TABLE 5.—Laboratory Endurance Test Results

SPIRAL BEVEL, SINGLE SPEED AXLE, 6.5 TO 1 RATIO, 21,000 LBS RATING LOAD—9,710 LB/IN OF TOOTH SURFACE		
LUBRICANT	TEST DURATION, WHEEL CYCLES AT FULL LOAD	AXLE CONDITION
MIL-L-2105 (SCL)	57,400	Medium ridging and rippling in pinion—heavy spalling on rollers of rear pinion bearing.
MIL-L-2105 (SCL)	0	Medium ridging in pinion at end of break-in.
MIL-L-2105 (SCL)	54,000	Heavy ridging, medium rippling in pinion.
MIL-L-2105 (SCL)	54,000	Heavy ridging, light rippling in pinion.
MIL-L-002105A (ORD) (SCPZ)	57,000	Heavy spalling of pinion teeth—no ridging—severe distress in rear pinion bearing.
MIL-L-002105A (ORD) (SCPZ)	27,000	Medium ridging in pinion —5 teeth broken from ring gear—severe distress in rear pinion bearing.
MIL-L-002105A (ORD) (SCPZ)	24,000	Heavy ridging in pinion.
MIL-L-002105A (ORD) (SCPZ)	45,000	Heavy ridging in pinion—3 teeth broken from ring gear—severe distress in rear pinion bearing.

CONCLUSIONS

Observation of results from tests in fleet trucks and the laboratory endurance tests lead to the following conclusions:

1. Axle failures occur on all three lubricants in the test fleet and are of the same type as those experienced by the fleet operator before the test was started.
2. For the three lubricants tested, there was no significant effect on the frequency of axle failure in the test fleet.
3. Axle failures are believed to be of two distinct types:
   a. Those resulting from metal fatigue in the pinion.
   b. General deterioration of ring and pinion contact surfaces and antifriction bearings caused by circulation of foreign materials in the oil.
4. Over-the-road trucking service may normally result in water contamination of rear axle lubricant up to 3½%. Bearing corrosion can occur when water contamination is 0.2% or less.
5. Laboratory endurance tests show that neither lubricant tested gives a satisfactory result which, in turn, indicates that test conditions are too severe to allow valid lubricant comparison.

BIBLIOGRAPHY

1. Cunningham, E. P. and Dinsmore, D. W., "The 'New Look' in Automotive Axle Gear Lubricants," presented at the Twelfth Annual Independent Oil Compounders Association Meeting, September 28-29, 1959.
2. Heinen, C. M., "New Developments In Gear Lubricants," presented at the SAE National Fuels and Lubricants Meeting, November 8-9, 1956.
3. Nelson, R. K. and Valentine, L. J., "High Horsepower And High Torque Performance of EP Gear Lubricants," presented at the ASLE Meeting, January, 1959.
4. Raymond, L., "New Horizons With New Gear Lubricants," presented at the SAE National West Coast Meeting, August 12-16, 1957.
5. Sands, T. P., "Development Of New Automotive Gear Lubricants," presented at the Twelfth Annual Meeting of the ASLE, April 17, 1957.
6. Streets, R. E., "Performance Testing of Gear Lubricants In Military Equipment," presented at the SAE National Fuels and Lubricants Meeting, November 8-9, 1956.
7. Williams, R. K., Brandow, W. C., and Schulte, J. W., "The Development And Application Of A Broad Performance Range Gear Lubricant Additive," presented at the Tenth Annual Meeting of the Independent Oil Compounders Association, September 22-24, 1957.

Emulsions used as brass rolling lubricants provide better cooling, adequate reductions, higher speeds and cleaner, brighter strip than most mineral oil or mineral oil-water coolant combinations. The paper describes several oil-in-warer emulsions which have met the user's requiremnts in a wide variety of brass rolling mill equipment.

Laboratory tests guided the supplier in the development of an emulsion with less tendency to stain brass. Prevention of water stain is a persistent problem in producing high quality strip. Viscosity of the mineral oil used in the emulsion is critical on 4-High Mill operations. Higher viscosities are necessary on intermediate or breakdown gauges and lighter viscosities on finish gauges.

Material and maintenance costs are comparable to mineral oil-water coolant systems. Operating personnel prefer to use emulsions for simplicity of application, easier stripping from the metal and easier "sticking" or starting of bars.

BRASS ROLLING EMULSIONS

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INTRODUCTION

Achievements of recent years in emulsion technology have permitted emulsions to replace oils in many new metalworking applications. Water, in addition to its low cost, is the better coolant, having double the specific heat, 3.7 times the heat conductivity and 10 times the latent heat of vaporization of oil. The trend toward building metal processing equipment capable of higher speeds has been paced by the development of more efficient water-based fluids.

While various brass working operations have been performed with water-base lubricants for many years, it is only in the last five years that emulsions have displaced mineral oil-water coolant systems to a significant degree in brass rolling operations.

This paper describes several oil-in-water emulsions which have been used for the past seven years in one brass rolling mill. A range of rolling operations is described starting with 3¼ inch thick slabs finishing on gauges down to 0.006 inch thick at speeds up to 1200 fpm.

All practices herein described refer to the authors' own company and not to the brass industry in general.

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April, 1960

EARLY MILL TESTING OF EMULSIONS

Emulsions had been tested experimentally for rolling brass as early as 1948. In these preliminary experiments emulsions then available proved unsatisfactory from the standpoint of rolling efficiency and staining.

In 1952, a small 4-high mill (6.5 and 15.75 x 16 in.), shown in Fig. 1, was converted to a reversing mill designed to operate at 1200 fpm with a single system for cooling and lubricating. An extensive series of tests involving both mineral oils and emulsions soon made clear the shortcomings of each type.

Numerous compounded mineral oils all gave unsatisfactory rolling results: maximum speeds of only 300-500 fpm, side skidding at the higher speeds, and excessive roll brassing. Most of the difficulties stemmed from inadequate cooling by the oil. Even relatively low viscosity oils (50 SSU at 100F) did not give adequate cooling. It was apparent that emulsions were needed to operate the mill at the rated speed.

Tests of emulsions indicated that satisfactory cooling and rolling could be obtained with several emulsions but all products tested caused excessive staining.

The first water-base fluid used for production rolling of brass on the 4-high reversing mill was not an emulsion but a soluble chemical coolant designed for machining and grinding. Good cooling was obtained with a 5-10 per cent solution of the chemical coolant, but to get the desired reductions and reduce brassing of the rolls it was necessary to add 7-10 per cent mineral oil. The resulting mixture was a rather unstable

Fig. 1. 4-High Reversing Mill (6.5 and 15.75 x 16 in.)

emulsion. Use of the mixture was discontinued due to excessive staining of brass strip before and after annealing and excessive roll brassing.

Next a mineral oil-petroleum sulfonate emulsion was tested. At 10% concentration good cooling and lubrication were obtained permitting maximum rolling speeds and normal reductions. This material was used for a period of three months. Again surface quality proved to be unsatisfactory due to staining of hard brass and also staining in the anneal which could not be removed by regular pickling procedures. Both oxides and sulfides were present on the stained strip. The sulfide stain was attributed to the sulfonate emulsifiers being reduced to sulfide at temperatures of 500-600C in a reducing atmosphere. Under these conditions so-called "inert", "unreactive" or combined sulfur does react with brass.

This emulsion also had a tendency to water-stain brass in a relatively short time. Since such stain is generally believed to be galvanic in nature, it seemed likely that the high pH of 9-10 was contributing to excessive staining. Although unsatisfactory for rolling, this material found use as a press drawing lubricant for brass.

A request was made to the supplier of the petroleum sulfonate emulsion for a product of equal lubricating ability but with low sulfur and low alkalinity. A new experimental emulsifiable oil meeting this description was received and this product is the one most used today.

After laboratory stain tests indicated the new product did give less staining than the petroleum sulfonate emulsion, it was tested in the 4-high reversing mill. At 5% concentration maximum mill speeds and reductions were obtained; roll brassing and staining were appreciably less than for previous emulsions tested.

EQUIPMENT USED FOR BRASS ROLLING

Table 1 lists four rolling mills which are currently using emulsion lubricant. Continuous cast 26 inch flat bars weighing 3100 pounds are cold rolled from 3.25 to 0.540 inch gauge flat sheets on a 2-high water cooled breakdown mill. Nine passes and two intermediate anneals are required.

After overhauling to 0.500 inch the flat bars are rolled on two identical 4-high straight-through mills referred to as a rundown and finish mill. On the rundown, strip is rolled from 0.500 to 0.102 inch thick without annealing. On the finish mill, strip is rolled from 0.102 inch to a minimum gauge of 0.012 inch with intermediate anneals as necessary. Prior to the use of emulsions both 4-high mills had been served by a common system using a compounded mineral oil as the lubricant and circulated water as the roll coolant.

For finishing light gauge slit stock down to 0.006 inch thick and up to 12 inches wide, the 4-high reversing mill is used.

TABLE 1.—Mill Equipment Used for Brass Strip Rolling With Emulsions

DESIGNATION	SIZE*	MAX. SPEED, FPM	GAUGE ROLLED, IN.
2–High Breakdown	30x36	180	3.25 -0.540
4–High Rundown	16 and 34x34	600	0.500-0.102
4–High Finish	16 and 34x34	1000	0.102-0.012
4–High Reversing	6.5 and 15.75x16	1200	0.064-0.005

*Work roll and back-up roll diameters by mill width.

A more recent addition to the continuous strip mill is a 31 inch wide Sendizmir Mill which is also used for finish work. A 100 SSU mineral oil is being used currently on the Sendzimir Mill but facilities are available for using emulsion also.

EMULSION TYPES CURRENTLY USED ON BRASS ROLLING

Three emulsifiable oils are now being used to roll brass strip from 3.25 inch continuous cast bars to finish strip of 0.006 inch gauge. Table 2 shows the distinguishing characteristics of each and the equipment in which it is used.

For slab breakdown on the water-cooled 2-high mills a conventional emulsifiable cutting oil at a concentration of 10-12 percent is used. This practice is not too critical since the slabs are oxidized, so roll pick-up is not a problem. Also, overhauling removes any stain which might develop. Product "A" is also used at 2 per cent concentration for grinding rolls. While product "A" contains sulfonates, it is not the same product as the one tested on the 4-high reversing mill.

Product "B" listed for intermediate rolling, was the result of a request of the user for a low sulfur, low alkalinity emulsion of good lubricating properties. It was the first product to give satisfactory performance in the 4-high reversing mill. Although both the rundown and the finish 4-high mills were being operated at capacity speed and reductions using a mineral oil-water coolant combination, a test of product "B" was arranged for the rundown mill. The main objective was improved surface finish. A major question was whether the emulsion could withstand total pressures of 1-1.5 million pounds generated by the mill.

A 5-6 per cent emulsion of product "B" proved to be equal to the former oil-water system both as a coolant and lubricant. No changes were made in the pass schedules and maximum mill speed was attained on finish passes. Immediate advantages noted were increased strip lustre and less "smut" and oil stain after annealing and pickling.

Tests on the 4-high finish mill with emulsion "B" were not successful. Bars would not track well, but side-skidded and cracked up. Skidding could be controlled only by lowering the speed or taking smaller reductions per pass. Most difficulty was encountered on rolling the lighter, hard finish jobs. Unlike the rundown mill where rolls are ground with a slight crown, the finish mill work rolls are ground perfectly flat and to a smoother finish.

As the skidding seemed to be due to too much lubricity or slip, the supplier was again consulted to see if a product could be formulated similar to "B" but with a lower viscosity base oil. Emulsifiable oil "C" was the result. Side skidding was eliminated and regular speeds and reductions were attained on the 4-high finish mill using emulsifiable oil "C" at 7-8 per cent concentration.

An added advantage of the lower viscosity product was even brighter finish than that obtained with "B". Product "C" is now used on the 4-high reversing mill used for finishing slit stock up to 12 inches wide. Although both "B" and "C" appeared to work equally well on the small 4-high reversing mill, they are not interchangeable on either the rundown or finish 4-high mills. A trial of "C" on the rundown mill resulted in excessive heat build-up and loss of shape control. Apparently on the heavier gauges and reductions, the additional viscosity is necessary to reduce frictional heat.

TABLE 2.—Properties of Emulsifiable Oils Used for Rolling Brass

PRODUCT DESIGNATION	A	B	C
BASE	MINERAL OIL	MINERAL OIL	MINERAL OIL
EMULSIFIER TYPE	PETROLEUM SOAP	NON-IONIC	NON-IONIC
PROPERTIES:			
Mineral Oil Visc., SSU at 100F	200	500	70
Total Sulfur, %	0.5	Less than 0.1	Less than 0.1
pH (5% Emulsion)	9.0	7.5	7.5
APPLICATION:			
Equipment*	2-Hi Breakdown	4-Hi Breakdown	4-Hi Finish 4-Hi Reversing
Outstanding Characteristics	Cheap, Good Anti-Rust	Bright Finish, Low Stain	Bright Finish, Low Stain

*See Table 1 for description of equipment.

MAINTENANCE PRACTICE

On each mill, maintenance personnel check the concentration of oil in the emulsion and add water or emulsifiable oil as required. A simple check method consists of adding Epsom Salts to 100 cc of emulsion and reading the volume of oil which separates after several hours.

A more complete analysis is conducted in the laboratory on daily samples from the 4-high rundown and finish mills. Viscosity of the oil phase, pH, and ash are determined. The viscosity check is necessary to determine the degree of contamination by lubricating oils or kerosene. The latter is used to aid sticking or starting of bars on the rundown mill. Ash values give a measure of the dirt and metallic sediment carried in the emulsion. About 0.1 percent is regarded as the upper limit. At this level the emulsion has a very dirty gray color. The pH fluctuates between 7.2 and 8.5 but has never dropped below 7.

The 4-high rundown and finish mills operate on separate 4500 gallon systems. On the 4-high rundown mill the change period varies from 3 to 6 weeks. Usu-

ally the change is necessitated by a decrease in the mineral oil viscosity due to kerosene contamination. Occasionally leakage of viscous roll neck bearing oils introduces the danger of staining in the anneal and a change is necessary.

The 4-high finishing mill is not subject to kerosene contamination and this system usually goes 6-8 weeks before it is finally changed due to a build-up in sediment which consists of very fine particles of brass, oxides and dirt. Much of the brass particles generated in rolling is floated to the top of the tank along with free oil while heavier particles are allowed to settle out. Periodic vacuuming of the collecting tank surface removes some of the free oil and metal particles. The emulsions are also filtered through a screen type self-cleaning filter.

The small 4-high reversing mill has only a 1000 gallon emulsion tank. Due to the smaller capacity and also because a brighter, finer finish is desired for this mill, the emulsion is changed about every two weeks.

Air plows do an efficient job of removing emulsion from the strip. On the 4-high rundown and finish mills a pair of air plows with 36 inch long nozzles on both top and bottom apply air at 2¾ psi; air velocity is 300-400 feet per second.

Emulsion is applied to the back-up and work rolls on top and bottom by a total of 34 nozzles. Rate is 300 gpm at 75 psi line pressure.

Areas around the mills are cleaner since using emulsion. While it is still necessary to use kerosene to start bars, less overall difficulty is experienced in "sticking" with the emulsion than with the mineral oil-water combination.

OTHER ROLLING APPLICATIONS OF EMULSIONS

Emulsion "B" has been used also for rolling shape aluminum and brass wire in a Turks-head machine. In this application it was necessary to add a rust preventive to the emulsion to protect machine parts. The rust preventing properties of the non-ionic emulsions are not as good as those of the conventional sulfonate type.

On a 3-stand flat wire mill rolling brass wire, emulsion "B" has also been used satisfactorily. To improve the detergent action of the emulsion some kerosene emulsion is mixed with emulsion "B". Rolling results with the mixture were more satisfactory than when emulsion "C" was used.

WATER STAINING

The problem of preventing water-stain on hard brass is a persistent one. The non-ionic emulsions give less staining of this type than the previous mineral oil-water combination and less than previous emulsions tested. Staining occurs most frequently on the hard-extra hard temper material. On some strip, stains develop in the interval between passes due to the high heat generated. Comparative testing in the laboratory has been helpful in screening emulsions, for their staining tendency.

Effective air plows are very important to remove excess emulsion from the strip before coiling.

Not all water-staining is caused by the rolling emulsion; moisture condensation from the atmosphere is also a factor responsible for staining in storage. This is illustrated by the fact that staining has also been observed on soft temper material and on hard temper material which has been cleaned and dried.

WATER-STAIN COMPARISON TESTS

1. Static Stain Test. Brass strips 3½ in. long x 2 in. wide x 0.015 in. gauge cut from a half-hard mill-finished coil are cleaned in sulfuric acid pickle, rinsed, and dried. A sandwich of four brass strips is made with a half milliliter of test emulsion between each layer. Strip surfaces contacting the emulsion are observed after 24, 48 and 72 hours at room temperature, or after shorter intervals at elevated temperatures. Emulsions whose staining characteristics are known are run with each test as standards of comparison. This test is severe in that a large excess of emulsion is present. Staining occurs at the air-emulsion interface and continues so long as water is present. Samples of stained test strips are shown in Fig. 2.

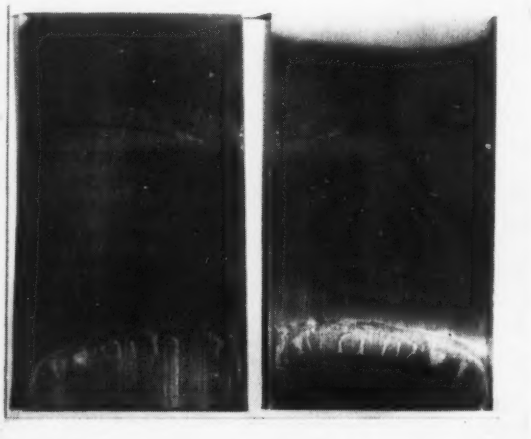

Fig. 2. Strips of 70-30 Brass After Contact With 5% Emulsion "B," 12 Hrs. at 150 F.

2. Rolled Metal Stain Test. Coils of mill-finished brass strip (2-3 in. wide x 0.020-0.040 in. gauge) are rolled to hard temper on a 2-high laboratory mill with test emulsions. After rolling, coils are wound and strapped and stored for 10 days. Application of emulsion, mill settings, wiping and coiling procedures are kept constant for all emulsions tested. The test is a comparative one and test emulsions are rated against those of known staining characteristics. Test coils are rated as rolled and after annealing and pickling.

Preliminary testing of the non-ionic emulsion "B" in the static stain test indicated a resistance to water stain for a period of 48-72 hours while the petroleum sulfonate emulsion developed stain in only 12-24 hours. The improved stain resistance of the non-ionic was borne out in the mill tests.

STABILITY OF EMULSIONS

The non-ionic emulsions have intermediate to good stability. In the mill no problems have been encountered in making a stable emulsion. Differences have been noted in the laboratory. The shelf life of the non-ionic emulsifiable oils discussed here appears to be under one year, after which time a stable emulsion cannot be formed.

Fig. 3 pictures several emulsions after standing 24 hours. The photos were taken using back lighting; light areas indicate where the emulsion has settled upward leaving clear water. The top photos show new emulsions made of products "C" (left) and "B" (right) 24 hours after being newly mixed in the laboratory.

Product "C" gives a more stable emulsion than "B". The bottom photo shows a used emulsion taken from the 4-high rundown mill seven weeks after charging with the product "B". In spite of contamination which had reduced the oil viscosity from 500 to 200 SSU at 100F, stability of the used emulsion is good.

Fig. 3. Stability of Non-Ionic Emulsions. Photos taken with Back-lighting, after 24 hrs. standing (top left) emulsion "C"; (top rt.) Emulsion "B"; (bottom) used emulsion from rundown mill.

FALEX FRICTION TEST

A bench type tester such as the Falex Lubricant Testing Machine (1) has several limitations as a means of predicting rolling oil performance. On the Falex machine, for example, unit pressures are much lower than those encountered in rolling; relative sliding speed of test surfaces is greater than in rolling; and under load the test pieces wear without being plastically deformed. The principal advantage of the Falex machine lies in its versatility; a variety of test materials can be used. Friction, wear, or seizure load can be determined.

In the test method adopted for comparing brass rolling emulsions, bronze vee blocks are pressed against a rotating steel pin. The pin and vee blocks are immersed in a pan of test fluid. The friction between the test pieces is measured as torque which is read in inch-pounds from the standard Falex torque gauge over a range of loads.

The basic test procedure has been previously described as the "one-minute step up load test". (2) After a three minute break-in period at 500 lb. load, the load is increased by 250 lb. increments and run for one minute at each load until failure occurs.

Fluid temperature is adjusted to 100F at the start then allowed to increase throughout the test. For the emulsions the maximum bulk fluid temperature was about 200-208F, measured by a thermometer resting in the lubricant pan.

Test pieces were bronze vee-blocks, made of SAE 64 alloy, a leaded phosphor bronze, having a Brinell hardness of 98 and the standard Falex steel pin, Rockwell hardness C 9.

FALEX TEST RESULTS

A marked difference in the torque versus load curves was noted for products "B" and "C". As shown in Fig. 4 emulsion "C" has a much higher torque at every load tested. The same curves apply to concentrations of 5 and 10 per cent in each case. The shaded areas indicate the spread obtained in torque for two runs at each concentration. The Falex test results agree with actual rolling results obtained on the 4-high finish and rundown mills. For the finish mill the 70 SSU mineral oil emulsion provides adequate lubricity and sufficient friction to prevent side-skidding. On the rundown mill lower friction makes possible maximum reductions without excessive heating and loss of shape.

Kerosene contamination of the emulsion in the rundown mill results in a higher Falex torque curve as might be expected. A test on used emulsion "B" in which the oil viscosity has been reduced to 200 SSU at 100F gave a torque versus load curve which was identical to that of "C" rather than "B". While this Falex data would indicate poor performance on the rundown mill, no difficulties, such as loss of shape control were encountered as was the case when emulsion "C" was used.

Steel pins used in the Falex tests also indicate the effects of high friction torque. Fig. 5 shows a dark rough surface for the pin used with "C" and a more shiny surface for the pin used with "B". The pin from the used emulsion has an intermediate brightness.

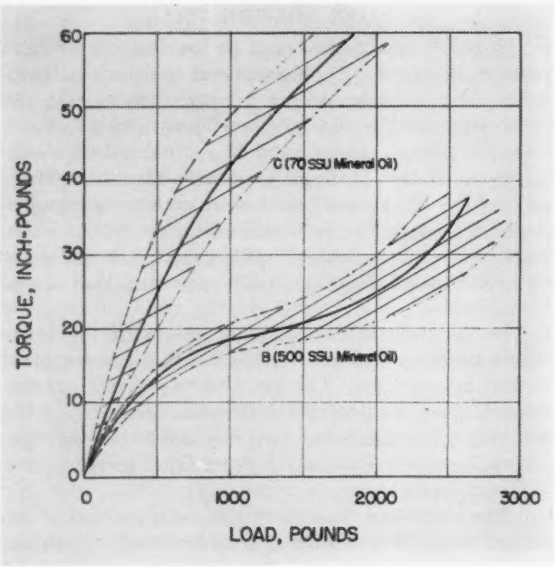

Fig. 4. Falex Friction Data on Non-Ionic Emulsions. Test pieces bronze vee-blocks and steel pins; starting temp. 100 F.; load applied by ratchet arm; 3 min. run-in at 500 lb. then 1 min. run at each consecutive 250 lb. interval until failure. Shaded area indicates spread on 2 runs each at 5% and 10% concentration.

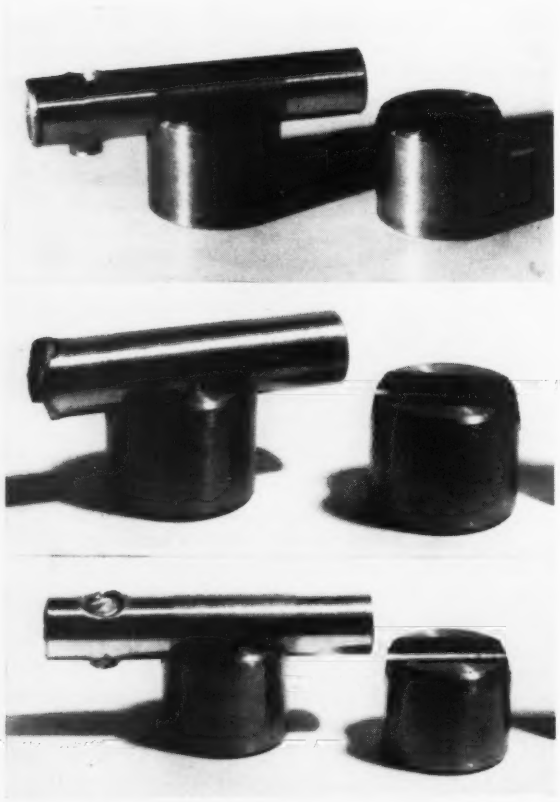

Fig. 5. Steel Pins and Bronze Vee Blocks Used in Falex Tests on Non-Ionic Emulsions; (top) 5% Emulsion "C"—Roughened Pin; (center) 5% Emulsion "B"—smooth pin; (bottom) Used emulsion—Partially roughened pin.

CONCLUSION

The decision to use emulsions for rolling brass was not based on the cost of lubricants, but on quality of the finished metal obtainable at the maximum speed of the equipment. Adequate lubrication with improved lustre of strip plus less residue left on annealing are advantages obtainable by the use of emulsions.

The solution to the water-stain problem which is associated with rolling with emulsions may lie in several approaches:

1. More efficient air plows, wipers or shrouds to remove emulsion from rolled strip or to prevent redeposition from splash after rolling.
2. Addition of inhibitors to the emulsion.
3. Use of lubricating materials in the emulsifiable oil which provide more protection against stain.

One theory on the effectiveness of emulsions for rolling is that the water only serves as a carrier for the lubricant which must be deposited out of the emulsion to be effective. However, examination of emulsions under the microscope raises another interesting possibility. The familiar Brownian movement associated with emulsions can be observed at magnifications of over 500X. Small spherical particles of petroleum oil measuring approximately 0.25 micron (0.00001 in.) are dispersed in the water with the aid of the helpful emulsifier. What happens to the minute oil particles as they are directed and pulled into the bite of roll and strip at speeds of 1000 fpm? Perhaps they act like minute "ball bearings" of oil. As "nothing rolls like a ball", the advantage of millions of "anti-friction bearings" is utilized at the contact area of the work rolls with the metal, plus the further good fortune of being in the presence of water—man's best coolant.

ACKNOWLEDGMENTS

The assistance of the rolling mills and Metals Research Department staff is acknowledged as well as Scovill Mfg. Company Management for permitting the paper to be presented.

REFERENCES

1. Crowley, C. A. and Faville, F. A., "The Evaluation of Extreme Pressure Lubricants" presented at Sectional Regional Transportation Meeting of the Society of Automotive Engineers, Chicago, Illinois, 1937.
2. Ryan, V. A., "Measurement of Lubricant Film Strength in the Region of Boundary Friction", *Lubrication Engineering*, Vol. 2, No. 3, September, 1946, pp. 101-106.

Application of Lubrication Experience to the

FREIGHT CAR JOURNAL

by Edwin Crankshaw
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This paper shows how the experience gained from the design and construction of hydrodynamically lubricated engine bearings has been applied to the development of a bearing for railroad freight cars. The new bearing incorporates four features dictated by well-known hydrodynamic principles. These are:

1. **Controlled clearance between bearing and journal.**
2. **Abundant supply of oil at the leading edge.**
3. **Leading edge relief to permit maximum swept-in oil.**
4. **Effective sealing for dirt-free operation.**

INTRODUCTION

The performance of the standard railroad journal box with its wastepacked oil reservoir and its partial bearing shell is probably responsible for the development of modern hydrodynamic theory. But, in spite of all that the box has taught, little has been done to make the box itself keep pace with the knowledge it has provided. In the light of what is now known about hydrodynamic lubrication, it appears that the railroad journal has several glaring deficiencies. For one thing, the waste packing furnishes an insufficient supply of oil and the journal is often starved. "Waste grab" is almost synonymous with "hot box", and the standard box is neither waterproof nor dustproof.

The standard assembly makes no attempt to control clearance. Yet it is known from engine bearing experience that there is an optimum clearance and that bearings can be designed that maintain it. It is high time, therefore, that existing lubrication knowledge and experience be applied to the railroad journal box.

At first thought, it would seem that designing a new railroad journal box encompassing these well-known principles would be a simple task; but the designer must be realistic and he cannot start from scratch. The new design must fit existing integral boxes with a minimum of alteration and the least possible expense. This paper will explain the development of such a bearing.

UNIT LOAD AND JOURNAL SPEED

An adequate oil film is, of course, essential for wear-free operation and the accepted way to obtain it is to keep the capacity number $\frac{P}{\mu N}\left(\frac{c}{\gamma}\right)^2$ within bounds. The unit load, however, must not exceed the carrying capacity of the bearing material and the speed must be low enough to prevent the generation of excessive heat.

The bearing in a fully loaded freight car has a unit load of about 525 psi of projected area, and, at a speed of 70 mph, the journal turns at about 800 rpm. The Diesel engine that pulls it probably has a unit load on the main bearing in the vicinity of 2000 psi and a crankshaft speed of perhaps 1000 rpm. A load of 2000 psi is not at all excessive for steel backed babbitt lined engine bearings, hence the 525 psi load on a freight car bearing is well within practical limits. A speed of 800 rpm is certainly not excessive in itself and it appears that, at 70 mph, the freight car bearing has a more favorable P/N ratio than does the Diesel engine. At lower speeds the P/N value of the freight car bearing increases; but it is known from experience with other types of installations that the high P/N ratios are not serious if there is, at the same time, a copious oil supply and a control of clearance.

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April, 1960

CLEARANCE AND HOW TO CONTROL IT

The standard journal box assembly makes no attempt to control clearance. When both journal and bearing are new, the radial clearance is 1/32 of an inch and the journal diameter is 5½ inches. Bearing shells are replaced more often than journals, but the journals, not replaced because of axial wear at the fillets, may be retained in service until wear has reduced them to a diameter of 5 inches. Thus a worn journal running in a new shell may have a radial clearance of more than ¼ of an inch. Such a condition means that the standard bearing cannot operate at its best until the bearing has worn to fit the journal.

The importance of clearance control can be demonstrated in a theoretical manner by plotting oil film thickness against radial clearance as shown in Fig. 1. This plot is standard practice in the design of engine bearings and it is used to determine the optimum clearance for a full journal bearing operating at a known speed with a known load and oil viscosity. The shape of the curve, not the numerical value of its points, is important here; hence the scale on each axis is omitted. Notice that there is a clearance that will produce a maximum oil film thickness and that excessively large clearance brings about a reduced oil film.

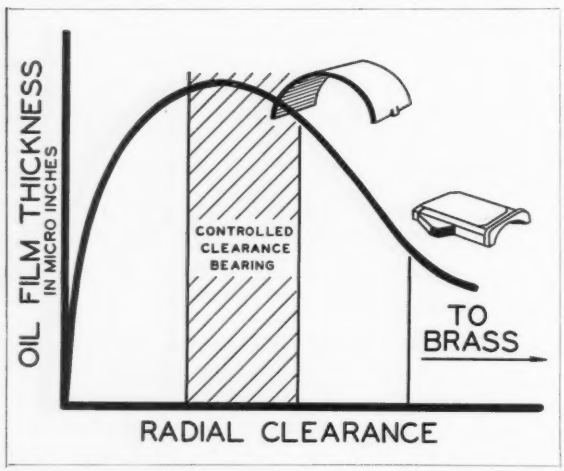

Fig. 1. How Clearance Affects Film Thickness

The importance of proper clearance has been demonstrated experimentally by Busby and Pigman (1) as shown in Fig. 2. Here measured values of the coefficient of friction have been plotted against measured values of ZN/P. Curve A is for a standard bearing with ¼ of an inch radial clearance and Curve B for the same bearing after it has become seated. Curve C is for a precision bearing with a radial clearance of 0.003 inch. Curves B and C are practically identical, meaning that a bearing with an 0.003 inch clearance gives the same friction value as a "worn to fit" standard bearing. In this instance, the heat generated by the bearing with excessive clearance (Curve A) is about 14 times that generated by the precision bearing (Curve C).

Of course, after a long break-in period, the coefficient of friction for the brass bearing will approach the precision bearing as Curve C illustrates. During this break-in the bearing will be extremely sensitive to operating conditions. Contact pressures will be high, oil films will be very thin, and the temperature will increase because of the heat generated. On the other hand, the precision bearing requires practically no break-in and will be ready for severe operation as soon as it is installed.

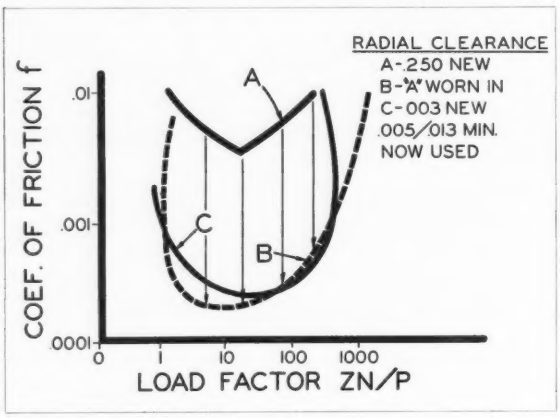

Fig. 2. How Load Factor Affects Friction

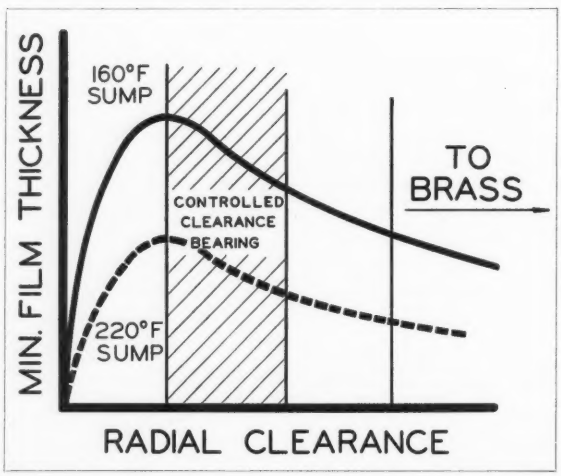

Fig. 3. How Temperature Affects Film Thickness

The dangers of operating at high temperatures produced by excessive clearance cannot be overlooked. Since oil film thickness is a function of oil viscosity and oil viscosity decreases with a temperature increase, it can readily be seen what happens to the oil film. A theoretical plot of oil film thickness against clearance for a full journal bearing operating in the same oil but at two different sump temperatures is shown in Fig. 3. Because of reduced viscosity, the film thickness at a 220F sump is only about 60% of the film thickness developed with a sump temperature of 160F.

Admitting that a bearing with a specific clearance is highly desirable, the designer must then turn his attention to a means of getting and controlling it. One method of doing this is to use the bearing insert type of construction that has been so successful in engine bearings. Applied to railroad bearings, this method consists of forcing a steel backed, babbitt lined bearing shell to conform to its circular housing by applying pressure at the bearing edges. The drawing in Fig. 4 shows how pressure is applied. The arc length of the semi-circular bearing shell is made slightly larger than the housing in which it is placed by an amount called "crush". When the two housing halves are brought together by the housing bolts, the bearing insert becomes "pressed" into the housing. Clearance can then be controlled by controlling the wall thickness of the bearing shell.

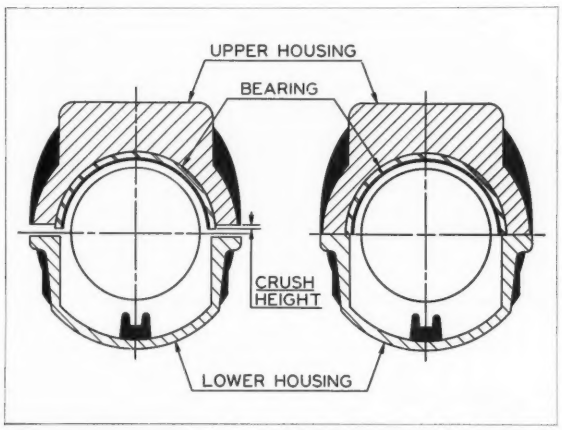

Fig. 4. Crush Applied to a Freight Car Journal Bearing

LUBRICATION AND HOW TO PROVIDE IT

In many applications loose waste is being superseded by lubricating pads. This may be considered an improvement since the pads reduce the tendency for "waste grab", but they do not alter the basic method by which oil is applied to the journal. Both the pads and the waste operate on the wiping principle and both are dependent on wick action for supplying the oil to the journal. Because the temperature situation is dependent on the quantity of oil supplied, a new design adopts the more positive lubricating method shown in Fig. 5.

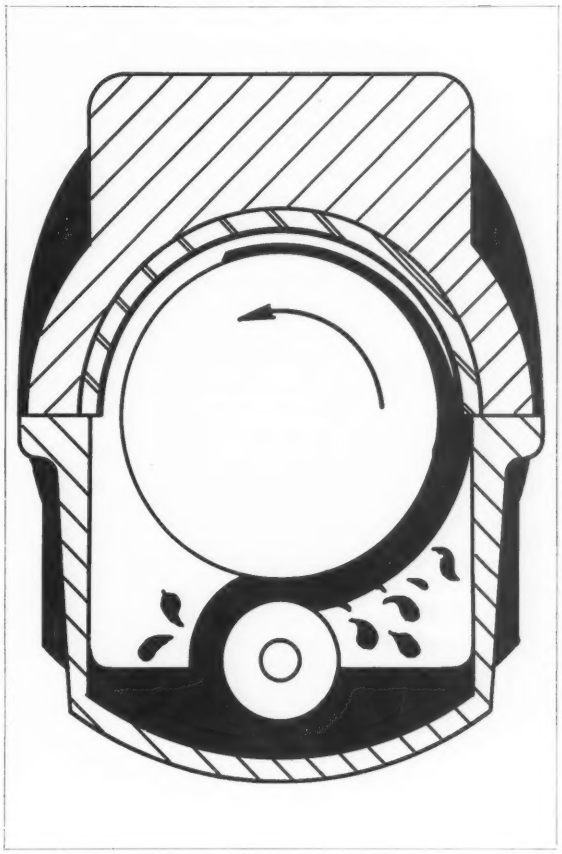

Fig. 5. Lubrication by Rollers

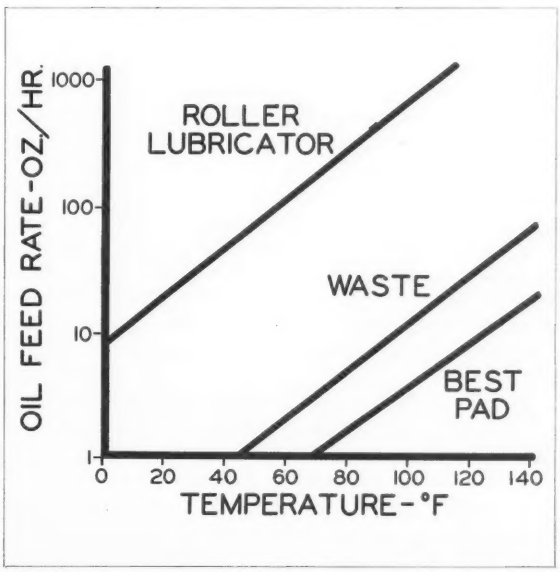

Fig. 6. Oil Feed Rates of Different Lubricators

This simple device consists of a series of felt rollers mounted on a common shaft just below the journal. The lubricator shaft is supported on nylon bearings and the rollers are held against the journal by a light spring pressure. As soon as the journal turns, oil is fed to the journal and the journal carries it to the bearing.

A number of tests have been conducted by various laboratories to determine the quantity of oil fed to a bearing. The data shown in Fig. 6 is the result of work done by one of the large oil companies. Their test procedure used actual bearings and lubricating components permitting oil to be applied to the shaft and then removed to measure its volume. About 60 times more oil is fed to the journal by rollers than by waste and the rollers do this without danger of waste grab or glazing. A waste pack or a pad merely wipes oil onto the journal and then wipes it off again so that the bearing never receives all the oil it can use. Lubricating rollers, however, can supply more oil than will cling to the journal.

Another advantage of the rollers is that they circulate the oil within the housing thus reducing oil temperature. In tests run at the AAR Laboratories, it was found that roller fed bearing ran from 40 to 82F cooler than the standard waste packed unit. This reduced temperature means that more viscous oil is supplied to the bearing and, as a consequence, the journal runs on a thicker oil film.

Unless the bearing is designed to use the oil brought to it, all the advantages of increased supply and increased circulation would be lost. To insure maximum swept in oil, the inside of each leading edge is given a chamfer as shown in Fig. 7. Without the chamfer, the leading edge would scrape off oil instead of leading it into the clearance space.

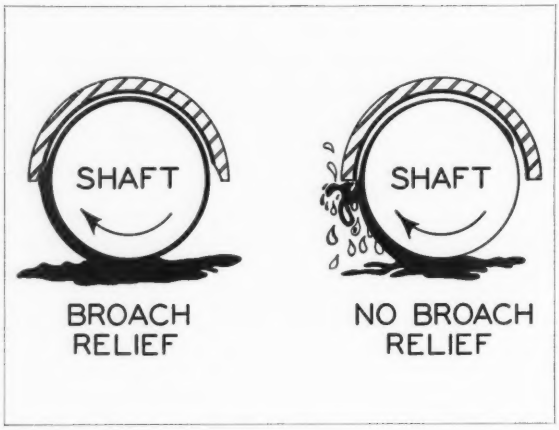

Fig. 7. Smooth Oil Flow into a Controlled Clearance Bearing. Oil Flow through Broach Relief vs. Scraping Action of No Broach Relief

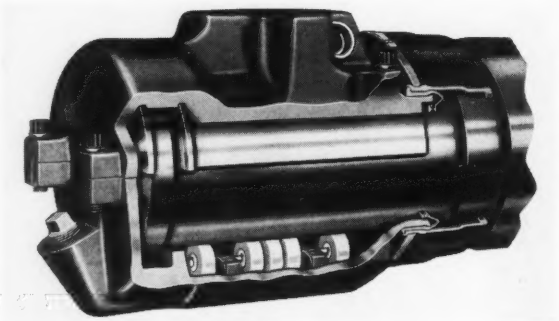

Fig. 8. Sealed Sleeve Bearing Cartridge for Railroad Freight Car Journals

A SEALED JOURNAL BOX CARTRIDGE

One reason for the high load capacity trouble-free operation of engine bearings is clean oil. Dirt particles in the oil, larger than the minimum oil film thickness, will become caught in the clearance space. Here they will either score the bearing and journal or become embedded in the lining material. In either event foreign material in the oil will cause local heating which may eventually result in a bearing failure. The cartridge type of railroad journal box shown in Fig. 8 has a dust guard and an oil seal capable of protecting the bearing from the hazards of dirty oil and preventing loss of oil through leakage. Thrust washers, one on each side of the journal flange, accommodate axial loads.

This cartridge incorporates all the design features previously discussed for it has—

1. Controlled clearance between bearing and journal.
2. An abundant supply of oil at the leading edge.
3. Leading edge relief to permit maximum swept in oil.
4. Effective sealing for dirt free operation.

The surest way to control bearing clearance is with a precision bearing and shaft combination. This will assure a low coefficient of friction and freedom from run-in difficulties.

An abundant oil supply to the bearing can be obtained with rollers and, with their delivery rate, bearing temperatures will be reduced.

Proper design of the bearing contour will permit the maximum amount of oil to enter the clearance space and provide an optimum film thickness.

Effective sealing will keep the dirt out of the bearing housing and keep the oil in.

In addition to these four items, dictated by hydrodynamic principles, the cartridge bearing shown in Fig. 8 has the practical advantage of fitting all current AAR standard freight car side frames.

This sealed sleeve bearing cartridge, because of the improved mechanical features, costs more than the conventional brass installation. This additional cost, however, is justified in view of the potential economical gain that could be realized through improved bearing performance, reduced maintenance and servicing.

REFERENCES

1. Busby, A. L. and Pigman, G. L., "Experimental Investigation of Railroad Journal Bearing Operation Characteristics", *Lubrication Engineering*, Vol. 13 (1957) p. 546.

DISCUSSION

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We have reviewed Mr. Crankshaw's paper with considerable interest since, as a leading supplier of lubricants and Engineering Service to the railroads, our Company has a direct interest in any innovations which may improve performance. In particular, we are aware that the hot box is undoubtedly the biggest single mechanical problem the railroads face today, and is one of major concern to all levels of railroad management.

The standard freight car bearing assembly is basically sound for the loads and speeds normally encountered in railroad service, and theoretically at least, bearing failures, i.e., hot boxes, should occur rarely if at all. However, this is a good example of where theory and fact are not in good agreement, since we are all aware that hot boxes do occur, often in epidemic proportions. A complete list of causes of hot boxes would be lengthy, but some of the more common and obvious reasons for failure of railway plain bearings are:

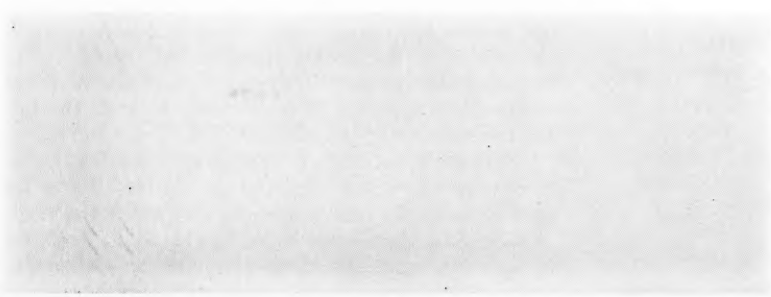
1. Oil starvation.
2. High localized loading of bearings due to misfitted, worn or defective bearings, defective or misplaced wedges, etc.
3. Bearings scored due to abrasive foreign material.
4. Poor journal surface finish.
5. Bearing misalignment.
6. Waste grab.

Although Mr. Crankshaw does not take up this list of bearing difficulties specifically or necessarily in order, he does clearly point out that the plain journal bearing assembly does have several deficiencies as far as practical operation is concerned. In discussing the requirements for a scientifically designed railway journal bearing, the author correctly emphasizes the importance of maintaining an adequate oil film by means of a controlled clearance bearing lubricated with an abundant, positive supply of oil. The need for protecting the oil in the closed system from the ingress of foreign material, as well as minimizing losses by means of an adequate sealing system has not been overlooked. The combination of the carefully designed fitted bearing plus the unique roller lubricators result in appreciably reduced operating temperatures, highly desirable in freight car operation. Actually, the features incorporated in Mr. Crankshaw's sealed journal box cartridge appear to largely overcome the difficulties which frequently plague the standard journal box.

We have devoted considerable thought to the lubrication of railway car journal plain bearings, and much research and laboratory testing as well. We have little or no control over the equipment which is lubricated by our journal box oils, but as far as we can direct them, our efforts have been in the same direction as Mr. Crankshaw's—that is, to improve the performance of freight car bearings. For example, our premium line of car oils contains an effective additive which provides lubrication under boundary conditions where the oil film has broken down due to abnormalities or improper load distribution. Mr. Crankshaw has mentioned the application of a full sized bearing to a worn journal as a case in point. In addition, we offer and strongly urge the use of seasonal grades of heavy duty car oil as free oil to compensate for changes in ambient temperature. A light, free flowing oil helps provide an adequate supply of oil in winter operations, while a heavy oil helps to maintain thicker oil films in summer heat. Our field experience with such products has confirmed their value.

We have been impressed with the design and construction of the Sealed Journal Box Cartridge, and believe it represents a real and timely contribution to the railroad industry. It has been a pleasure to review this interesting and informative presentation.

Editor's Note: Authors are furnished a copy of each discussion and invited to submit a closure. Since no closure was submitted for the above article, it may be assumed that the author either concurred with the discussor or did not feel that a reply was necessary.



Statistical Analysis of

LUBRICANT TESTS

by J. J. Geissler,

Statistician, U. S. Steel Research Laboratory, Monroeville, Pennsylvania

W. J. Youden of the National Bureau of Standards has devised a method of graphical presentation of the results of interlaboratory tests that is considered applicable to lubricant research and development. This method requires few samples and the minimum of statistics; it yields results that are useful and easily interpreted. With its use, helpful information can be obtained on the differences between laboratories.

INTRODUCTION

In the manufacturing of lubricants, the processes are controlled and the product quality is determined by appropriate tests. Because the quality of the product is contingent upon the results of these tests, the manufacturer should know how well the results of certain lubricant tests can be repeated in his own laboratory and how well these results will be reproduced on the same lubricant in another laboratory.

The purpose of this paper is to discuss an interlaboratory program that can be used to answer the above questions. This program requires a minimum number of samples and is very easy to analyze. It employs a graphical method for analyzing interlaboratory test data. A general scheme for this purpose was devised by W. J. Youden (1, 2) of the National Bureau of Standards Applied Mathematics Laboratory.

A hypothetical problem is described and analyzed in this presentation to illustrate in some detail the graphical method of analysis.

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April, 1960

GRAPHICAL METHOD OF ANALYSIS

In this method, two random samples, one from each of two materials, are sent to each of the laboratories cooperating in the program. The two samples are denoted as X and Y. Each laboratory has one analyst analyze the two samples on the same apparatus for specific properties and reports the results. When all the results have been reported, they are used to prepare a graph. The two results from each laboratory are interpreted as the coordinates of a single point; the x-coordinate is the result of sample X, and the y-coordinate of sample Y. Each point on the graph represents the results of a particular laboratory and is appropriately labeled.

Two median lines are then drawn on the graph, one parallel to the x-axis and the other parallel to the y-axis. These lines are drawn in such a way that there are an equal number of points (laboratories) on either side of each line; hence the name "median line." (If one or two laboratories are definitely separated from the others on the graph, these points should not be used to locate the median lines.) A third line is drawn on the graph so that it forms a 45-degree angle through the intersection of the median lines.

The interpretations of the results of such an interlaboratory test are made from the distribution of the points among the four quadrants into which the graph is divided by the median lines. The standard deviation of an observation, which is a numerical measure of variability, can be determined by multiplying the aver-

TABLE 1.—Results of First Program

SAMPLE	STABILITY VALUES FOR A GIVEN LABORATORY									
	A	B	C	D	E	F	G	H	I	J
X	17	17	27	35	14	26	15	8	14	21
Y	22	24	20	26	11	21	34	31	5	22

age perpendicular distance of the points from the 45-degree line by 1.2533. Multiplying the standard deviation by the proper constant (K), given in Table 1 and the accompanying discussion in reference (3), will yield an estimate of the repeatability of the test. Repeatability is a quantitative measure of the variability of a single operator in a given laboratory employing generally the same apparatus and within a brief interval of time. It is defined as the greatest difference between two single and independent results that can be considered acceptable (not significantly different) at the 95 per cent probability level.

ILLUSTRATION OF THE GRAPHICAL METHOD OF ANALYSIS

The method of graphical presentation can best be explained by an illustrative problem. The data used in this example are purely hypothetical and were chosen so that various distribution patterns would be found by the graphical method. These patterns best illustrate the conclusions that can be drawn from the graph.

Ten laboratories showed an interest in cooperating in an interlaboratory program to determine the precision of the roll-stability tester, which uses the ¼-scale-cone method for determining the penetration of the material after rolling. The program was initiated because past experience had proved that results on the roll-stability test did not compare favorably between laboratories.

As the first attack on the problem, a preliminary program was set up in which each of the 10 laboratories was to determine the roll stability of two random samples (X and Y), each from a different lot of grease. Table 1 presents the results of this test.

These data were plotted by the graphical method explained above, and Fig. 1 was obtained.

This figure shows a good distribution of points among the four quadrants; but all the points except B, A, and J deviate far from the intersection of the median lines. However, in general each point is very near one of the median lines. Such a pattern indicates that the results are good on one sample and rather bad on the other. This phenomenon may be caused by many factors, such as (a) a lack of homogeneity in the samples, (b) the nature of the test procedure, which gives rise to errors, and (c) carelessness in carrying out the procedure. Such a scattering of points about the 45-degree line suggests that the repeatability of the test is poor. Table 2 gives the method for calculating the repeatability from the graph.

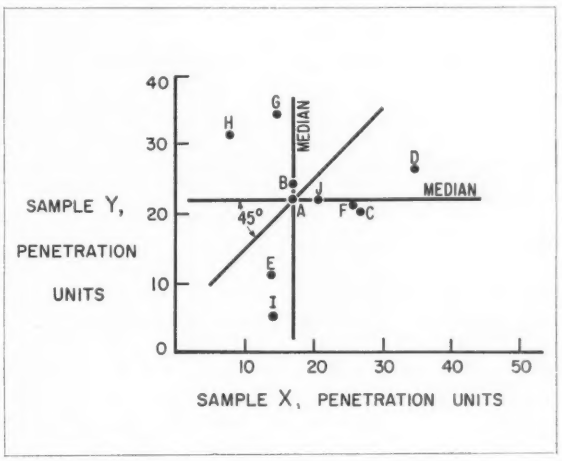


Fig. 1. Graphical Presentation of Results from First Program.

TABLE 2.—Distance of Each Point from 45-Degree Line (First Program)

LABORATORY	DISTANCE FROM 45-DEGREE LINE
A	0.00
B	1.40
C	8.40
D	9.80
E	5.60
F	7.00
G	9.80
H	12.60
I	9.80
J	2.80

Average Distance from 45-Degree Line $= \frac{67.20}{10} = 6.72$

Standard Deviation of One Observation $= (1.2533)\ (6.72) = 8.42$

Repeatability of Test $= K\ (8.42) = (3.20)\ (8.42) = 26.94$

The results of this interlaboratory test were sent in graphical form along with the interpretations to each of the cooperating laboratories. Each member was asked to examine his test procedures and to make

TABLE 3.—Results of Second Program

SAMPLE	STABILITY VALUES FOR A GIVEN LABORATORY									
	A	B	C	D	E	F	G	H	I	J
X	17	27	27	35	14	26	20	18	34	26
Y	12	24	20	36	11	21	19	11	35	27

modifications where he judged them necessary. After all the cooperators had had sufficient time to study their procedures for running the roll-stability test, another set of random samples from the same grease was sent to each laboratory. Table 3 presents the results of the second interlaboratory program.

Again the results were plotted by the graphical method, as shown in Figure 2.

The results of the second program are almost self-explanatory. The points on the graph are distributed in the upper right and lower left quadrants. Such a distribution requires an explanation different from those given for the graphical presentation of the initial test. Here the laboratories are consistently doing careful work, but each has introduced some modification into his procedure so that all the results are either too high or too low. However, all the points are located closer to the 45-degree line than they were in the initial test, which indicates that the repeatability of the test has been improved. This is the result of each laboratory studying and modifying their test procedure. The repeatability of the second test is given in Table 4.

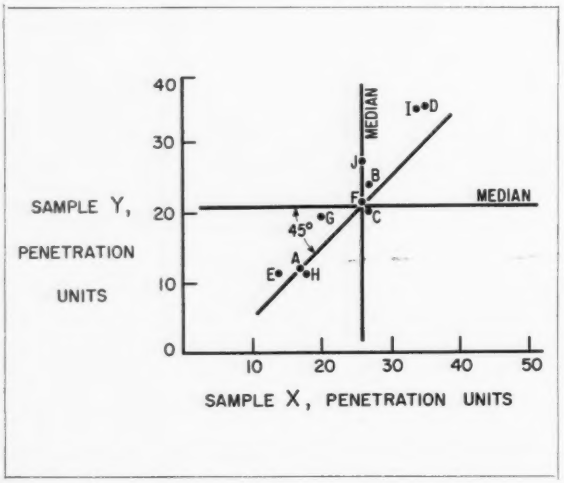


Fig. 2. Graphical Presentation of Results from Second Program.

TABLE 4.—Distance of Each Point from 45-Degree Line (Second Program)

LABORATORY	DISTANCE FROM 45-DEGREE LINE
A	0.35
B	1.75
C	1.05
D	3.85
E	1.40
F	0.35
G	3.15
H	1.05
I	4.55
J	4.55

Average Distance from 45-Degree Line $= \frac{22.05}{10} = 2.205$

Standard Deviation of One Observation $= (1.2533)\ (2.205) = 2.76$

Repeatability of Test $= K\ (2.76) = (3.20)\ (2.76) = 8.83$

TABLE 5.—Results of Third Program

SAMPLE	STABILITY VALUES FOR A GIVEN LABORATORY									
	A	B	C	D	E	F	G	H	I	J
X	27	23	27	25	24	26	24	22	23	22
Y	22	27	26	26	21	21	25	25	23	21

Because the results of the second program clearly showed that the repeatability was considerably improved over the first program, and that each laboratory was now operating at the same repeatability, the next step in studying the roll-stability test was to attempt to eliminate the bias that existed between laboratories. To do this, the cooperators met to discuss their test procedures and rewrite the standard test procedure to be followed by each laboratory. Therefore, another set of samples, similar to the previous samples, was sent to each of the cooperating laboratories for analysis by the new test procedure.

The results of the third program are given in Tables 5 and 6 and Fig. 3.

TABLE 6.—Distance of Each Point from 45-Degree Line (Third Program)

Laboratory	Distance from 45-degree line
A	2.45
B	3.85
C	1.40
D	1.75
E	1.05
F	2.45
G	1.75
H	3.15
I	1.05
J	0.35

Average Distance from 45-Degree Line $= \frac{19.25}{10} = 1.925$

Standard Deviation of One Observation $= (1.2533)\ (1.925) = 2.41$

Repeatability of Test $= K\ (2.41) = (3.20)\ (2.41) = 7.71$

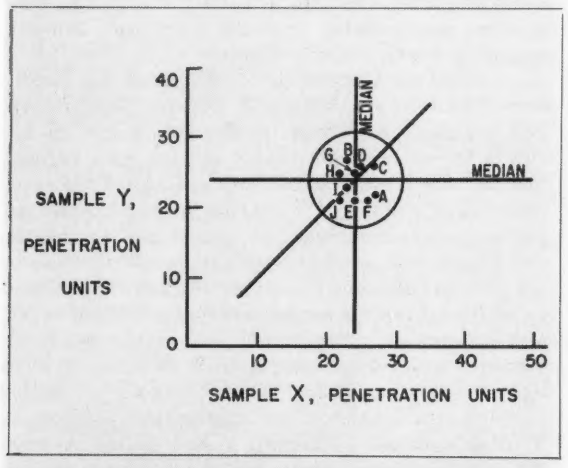


Fig. 3. Graphical Presentation of Results from Third Program.

Figure 3 shows the points distributed almost equally among the four quadrants and forming a small circular pattern around the intersection of the median lines. A feature of the graphical method, which has not been pointed out before, is that a circle centered at the intersection of the median lines and with a radius equal to 2.5 times the standard deviation of one observation should contain at least 95 per cent of the points. If any point falls outside the circle, the laboratory represented by that point is erratic or is using a procedure which deviates from that used by the other laboratories.

Such a circle has been drawn in Fig. 3; it contains the points of all the laboratories. It can now be said that the laboratories are all using the same procedure and that the repeatability of the test is 7.71.

DISCUSSION

The method discussed in this paper used a graphical presentation of the test data that allows cooperators to tell at a glance how the results of their laboratory compare with those of other laboratories. It employs the minimum of statistical processing and yields useful, easily interpreted results. The graph can point to various ways in which corrective action should be taken, such as (a) elimination of the biases, if any, in the techniques used by the various laboratories, and (b) the need for an improved test procedure. The graph also yields an estimate of the repeatability of the test procedure.

To carry out the entire program described above for standardizing the roll-stability test, each laboratory was required to analyze only six samples of grease, and the minimum amount of statistics was necessary to summarize the results. While the example used is hypothetical and the conclusions are almost obvious, it has been the author's experience that most interlaboratory tests follow a similar pattern.

Often this method of graphical presentation will be the only method needed. However, there are cases in which a more comprehensive program is required; for these, the method of graphical presentation may be employed to make a preliminary survey of the situation.

REFERENCES

1. Youden, W. J., "Graphical Diagnosis of Interlaboratory Test Results," *Industrial Quality Control*, Vol. XV, No. 11, May 1959; pp. 24-28.
2. Youden, W. J., "Evaluation of Chemical Analyses on Two Rocks," *Technometrics*, Vol. I, No. 4, November 1959; pp. 409-417.
3. "Proposed Recommended Practices for Applying Precision Data," ASTM 1953 D-2 Book, Appendix IV.

ASLE Technical Digest

Papers which, because of space limitations, cannot be published in full in Lubrication Engineering or ASLE Transactions.

"The Effect of Radiation and Other Environmental Conditions on the Performance of Greases," by P. J. Agius, and A. L. Morris, Esso Research Limited, Abingham, Berkshire, England

The behavior of some greases has been investigated under a number of environmental conditions to determine their stability characteristics for use in aircraft and nuclear power reactor applications. The environmental stresses considered were atmospheric exposure in the case of aircraft applications, and nuclear irradiation, temperature, carbon dioxide, air, oxygen and mechanical working for the nuclear applications.

The greases examined fall into two groups, soap and non-soap thickened greases. In general, soap thickened greases are fibrous in nature while the non-soap thickened variety retain the original micro-structure of the thickening agent.

In specialized low temperature aircraft applications, the useful limit of a grease is determined by hardening, and thus is normally dependent on the freezing point of the base fluid, typically on ester. However, it is also possible for surface hardening to take place upon atmospheric exposure and this can be dependent on the thickening system. It has been found that surface hardening can be caused by atmospheric moisture, especially when the thickener is formed in situ in the presence of an ester base. There is evidence that the secondary ester decomposition products produced under these conditions, particularly alcohols, act as intermediates and promote surface hardening in the presence of water vapor. The use of preformed thickener overcomes this effect and results in an ester based grease with excellent low temperature properties, and no more hardening than is associated with greases based on mineral oils.

For nuclear applications greases were tested for radiation stability using a 4 MEV linear electron accelerator with dose rates in the range of 10^6 to 10^7 rad/min. Integrated doses of 10^8 to 10^9 rads were chosen, since the former represents the point at which changes are initially observed in conventional oil based greases, and the latter the limit at which complete breakdown of the same product occurs. Micropenetration was used as a measure of breakdown due to irradiation. The wholly non-fibrous greases such as those based on bentonite and carbon black were found to be most stable to irradiation. A calcium complex grease, which is intermediate in structure type as regards fibrous and nonfibrous components, showed behavior more in line with the non-fibrous class. A complex sodium grease, which is more fibrous in nature, was found to exhibit breakdown resulting in the grease becoming inhomogenous. Greases, such as lithium soap types, having effectively a completely fibrous structure were found to break down drastically under irradiation.

A modified version of the ASTM D-1263-53T wheel bearing test was used to investigate the ability of greases to withstand the effects of mechanical working at elevated temperatures in air. The entirely non-fibrous greases, particularly the carbon black and bentonite thickened types were found to be most stable with regard to oil bleeding and consistency change.

The effect of grease exposure to carbon dioxide was determined by subjecting a thin layer of grease to a carbon-dioxide atmosphere in a Norma-Hoffmann bomb. The greases were tested under 110 psig at 210 F for 100 hours. The results obtained showed that conventional sodium and lithium greases react with carbon dioxide as evidenced by a significant pressure drop, decrease in dropping point and change in micropenetration. The sodium complex grease tested took up only a small amount of gas, however, it exhibited a decrease in dropping point and micropenetration. The less fibrous calcium complex grease took up a similar amount of carbon dioxide as the sodium complex grease but exhibited a less pronounced change in dropping point and micropenetration. The non-fibrous, greases were least affected with the carbon-black type appearing most inert since it did not take up carbon dioxide, had a stable dropping point and exhibited negligible change in consistency.

Tests were also run in a ball bearing rig under a carbon dioxide atmosphere at elevated temperatures. The angular contact test bearing was subjected to a 100 lb. thrust load and rotated at 1440 rpm. Before a test the bearing was packed with grease and the excess removed by spinning the bearing by hand. After 100 hours continuous testing, the condition of the bearing and grease was assessed with particular attention being paid to signs of oil bleeding. At 150 C the fibrous conventional lithium grease was found to bleed heavily and disintegrate. The non-fibrous carbon black and bentonite greases bled only a trace amount and ended up in excellent condition. The partially fibrous calcium complex grease assumed an intermediate position, exhibiting moderate oil bleeding and hardening. At 200 C the sodium complex grease broke down while the performance of the carbon black and bentonite greases was excellent.

(Digested by H. J. Connors)

Lubrication Abstracts

Edited by W. E. Campbell

Selected literature compiled by members of the Technical Committees and Industry Councils of the Society.

G. S. Reichenbach (Massachusetts Institute of Technology, Cambridge, Mass.), "The Importance of Spinning Friction in Thrust-Carrying Ball Bearings," *Jour. Basic Engg.* v. 32, series D, no. 2, 1960, pp. 295-301.

Tests with ball bearings of the thrust type show that the main source of friction is due to the spinning action of the balls. The so-called rolling friction moment is an order of magnitude smaller than the spinning moment, and is relatively insensitive to lubrication. However, since the spinning moment is due to actual sliding within the contact zone various oils may cause large changes in the friction coefficient. High temperatures may cause desorption of the lubricating oil film, resulting in abrupt changes in the friction moment. Changes in geometry of the bearing which affect the amount of spinning will result in corresponding variations in the overall running torque. Many ball bearings are forced by geometrical considerations to have a considerable amount of spinning. This fact should be given consideration when specifying lubricants. For high temperature operation the use of liquid lubricants does not seem feasible because of the desorption problem. The use of solid film lubricants either applied mechanically to the surface or chemically formed in place would seem more practical. *(Abstractor: Weldon C. Cook)*

A. G. Cattaneo (Shell Development Co., Calif.), R. A. Coit, S. S. Sorem, "Operation of Rolling Element Bearings in Protective Atmospheres," *Scientific Lubrication* V. 12, no. 4, 1960, pp. 26-8.

Antifriction bearings operating at elevated temperatures must be shielded from oxygen to prevent abrasion by oxidation products and provided with a renewable film on sliding surfaces to prevent scuffing. "Wearing in" by running in mineral oil is a necessary preliminary to high temperature operation. Inert shielding gases provide sufficient traces of oxygen above 600°F to permit formation of red iron oxide and abrasive failure. Organic vapors in correct proportions with a shielding gas can prevent oxidation of bearing elements without leaving carbon contamination. Sulfur or phosphorus additives may be used to provide an anti-scuffing film on sliding surfaces but can be replaced by organic films of unknown nature composed by carbon, hydrogen and oxygen. A protective atmosphere system using a mixed ethylene oxide-propylene oxide polymer in mist form is found to act as a conventional mist lubrication system up to 600°F. Above this temperature, the polymer decomposes into volatile components which provide both protection against oxidation and an anti-scuffing film. Satisfactory bearing operation to 800-900°F and limited operation to 1100°F is attained. Ultimate bearing life is not determined. Performance is judged on the basis of smooth operation and the absence of severe damage after test periods of 20, 50, or 100 hours. Glossy surface films are associated with low wear and long life, dull films with rapid failure. *(Abstractor: F. J. Kolano)*

Yu. S. Zaslavskii, G. I. Shor and R. N. Shneerova, "Mechanism of the Decomposition of Protective Films Formed by Anti-corrosion Additives", *Doklady Akad. Nauk SSSR*, v. 128, no. 5, pp. 1010-11.

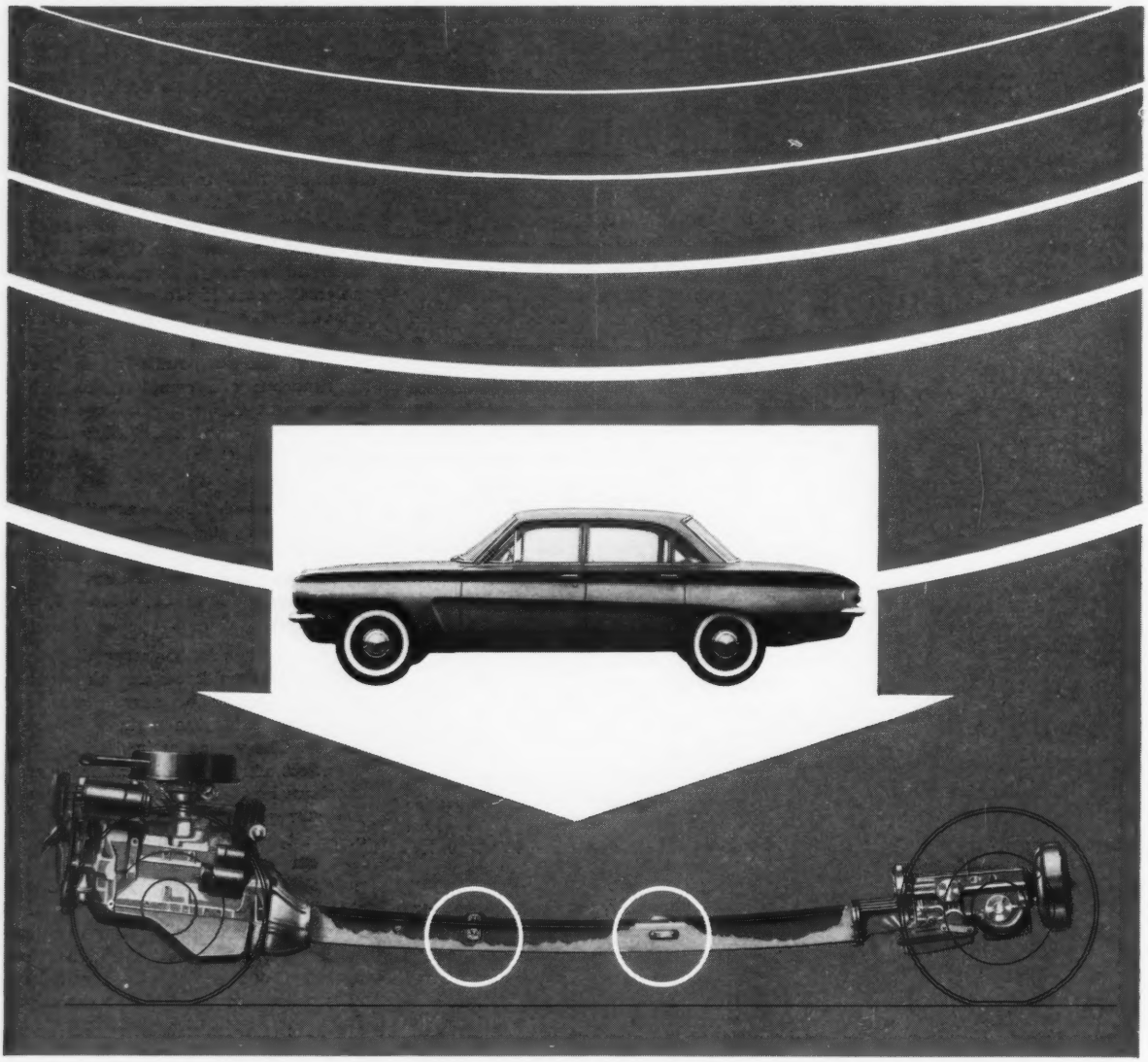
Radioactive tracer techniques are used to determine the amount of protective film formed and retained on lead plates as they are cycled in and out of hot oil. The plates are immersed in oil (140°C.), which in one case contained 2.8% diphenyl sulfide labeled with S^{35} and C^{14}, and 0.66% stearic acid, and in a second experiment contained the same quantity of unlabeled additive and 0.05% tridecylic acid labeled with C^{14}. The amounts of additive and acid bound to the lead plates are determined by radiotracer counting and plotted as a function of immersion time. The additive and acid films reach maximum thickness in about two hours and then synchronous removal by decomposition starts. The rate of removal is rapid initially, but tails off. The authors propose that the synchronous removal of the acid and sulfur-containing films is due to chemical reaction between the acid and the lead sulfide (formed after decomposition of the complex formed by the additive and the metal) thus giving a lead salt soluble in the oil. The sulfur escapes as H_2S. Similar experiments are conducted at 185°C with an oil containing 0.5% triphenyl phosphite, labeled with C^{14}, and 0.66% stearic acid and an oil containing 0.5% tridecylic acid, labeled with C^{14} and 0.5% unlabeled triphenyl phosphite. Unlike the earlier case of the sulfur-containing additive, the removal of the films formed by the acid and by the phosphorous additive radicals is both simultaneous and complete. This indicates that the acid does not react with the lead phosphite. *(Abstractor: Edward H. Loeser)*

C. F. Kettleborough (Department of Mechanical Engineering, University of Auckland, Auckland, New Zealand), "Density Variation Effects in Stepped-Thrust Bearings," *ASME Trans.*—J. Applied Mechanics, v. 7, Ser. E, no. 3, Sept. 1959, pp. 337-40.

The problem of the stepped-thrust bearing is considered and the equations are solved by assuming mass continuity rather than volumetric continuity. The variation in density and the effect of stepped discontinuity are considered and the computed theoretical curves illustrate the importance of density on operation of the bearing. The curves, in part, explain results previously published. The results of the considerations presented are shown on plots of load criterion versus a film-thickness function and a friction function. In the case of film thickness, there is one significant variation from the constant density case for values of the film-thickness function above 0.4 when the load intensity is high. As the film thickness function decreases below 0.4 the effect of density variation increases. When the load intensity is decreased the deviations from the constant-density curves occur at smaller values of the load criterion and at smaller values of the film thickness. In the case of the friction function, the curve which allows for density change entirely suppresses the negative slope of the curve in the case of the film thickness function. As the load intensity is decreased the friction curve follows the constant density curve further up the portion having a negative slope before breaking away. Different curves are obtained for each distinct load intensity except when hydrodynamic conditions predominate. These distinct curves have not been reproduced in experiments. *(Abstractor: P. G. Smith)*

(Continued on page 191)

NEW DEPARTURE CASE HISTORY



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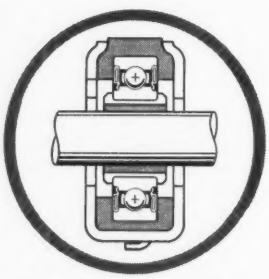

Two N/D ball bearing assemblies like this are mounted within "bent" torque tube.

NEW DEPARTURE

BALL BEARINGS · PROVED RELIABILITY YOU CAN BUILD AROUND

LUBRICATION ABSTRACTS

(*Continued from page* 189)

G. V. Vinogradov and O. E. Morozova (Inst. Petrochem. Synthesis, Moscow, U.S.S.R.), "A Study of the Wear of Steel under Heavy Loads with Lubricants Containing Sulfur-Based Additives," *Wear*, v. 3, no. 4, 1960, pp. 297-308. (In English).

A 4-ball tester is used to study the wear of hardened steel balls at contact stresses of 300 to 460 kg/mm² in purified bright stock and in 1% solutions of sulfur and dibenzyl disulfide therein. It is shown that the usual scar diameters, by themselves, do not quantitatively measure wear since the depth of the scars varied. The depth of the wear scars, measured profilometrically, decreases under the action of these additives and when the sliding speed is lowered. Metallographic and microhardness studies showed that non-etching surface layers, 20 to 30μ thick, of great hardness were formed under seizure conditions. Below this non-etching layer is a layer of partially annealed steel which facilitates the plastic deformation of the steel in the friction zone and the development of adhesion between the rubbing surfaces, resulting in seizure. The structural changes that occur in the surface layers of steel worked for a long time under heavy friction conditions in a hydrocarbon oil are different from those obtained in an oil containing these additives. The theory has been put forward that on seizure in the presence of the sulfur-containing additives submicroscopic relatively soft films of iron sulfides form on the very hard surface layers. The specific nature of heavy friction conditions is defined by the formation of a multilayer structure in the friction zone of the steel. *(Abstractor: Edward H. Loeser)*

G. H. Clark (Esso Petroleum Co. Ltd.), "The Lubrication of Turbine Gearing", *Scientific Lubrication*, v. II, no. 6, 1959, pp. 12-21, 38.

Marine gear design and causes of failure are discussed, with drawings of tooth action. Lloyd's K factor (Lloyd's Register of Shipping) is a measure of tooth loading and is defined; values given are 35 to 80 for older gears, 270 for post-war designs, 500 anticipated for hardened gears. Photos of scuffing and pitting failures are shown; pitting is reported to be the most prevalent cause of failure. The composition and properties of nine British gear steels are tabulated. *(Abstractor: E. A. Ryder)*

A. D. Varanelli, "Brief Literature Survey Relating Temperature to Boundary Lubrication Phenomena," General Electric Co., Atomic Products Div., Cincinnati, Ohio, APEX-265, Sept. 1956, 35 p. (Available from OTS, Washington, D. C. 35¢.)

A survey covering more than 250 references indicates that increased temperatures have little direct effect on friction and wear; hydronamic lubrication can be extended to an upper limit of 1000 F for closed systems; certain classes of solids can function on the range of 500-1000 F; special temperature-stable coatings can minimize wear between 1000 and 2000 F. *(Engineering Index Abstract, per W. E. Campbell)*

A. D. Newman (Glacier Metal Co., Wembley, England), "Extreme Pressure Lubricants for Marine Gears" Proc. I. Mech. Eng. v. 174, no. 5, 1960, 22 pp. discussion; *Int. Shipbuilding Progress*, v. 6, no. 63, Nov., 1959, pp. 486-92.

The original development of e. p. oils for marine turbine gears in Britain was necessitated by high load carrying capacity needed in oils for very accurate, finely finished, surface hardened naval gears, carrying loadings three to six times as high as in normal marine practice. The Admiralty specification for such oils, OEP-90, calls for IAE gear machine tests; this criterion is a high load carrying test on hardened and ground gears, at medium speed. However, in marine service, high-load high-speed performance is not the most important requirement of an e. p. oil. Scuffing troubles are prone to arise on trials, often occurring on the astern faces of teeth, under maneuvering loads. An ideal e. p. lubricant must have increased load-carrying capacity over the whole range of speed and load for the material combinations likely to be used, and not be inferior to a plain oil in other properties. A disc machine used at PAMETRADA is described; this has axes at 90° and the periphery of a small disc rubs against the flat face of a larger disc, with the slide/roll ratio controlled by the relation of the disc axes. For each oil tested, 64 tests are made, comprising four slide/roll ratios, four speeds, and four pairs of specimens at each combination. Some of the oils show improved load-carrying capacity as compared with a plain oil, over the whole range of conditions; others show improvement at some conditions with little effect at others. Some oils seem to need slight scuffing to achieve full effect of the additive; some reduce the coefficient of friction and some increase it. The author pleads for separate investigation of the two processes of scuffing, that of lubricant effects, and that of surface effects after the lubricant has acted on the surface. *(Abstractor: E. A. Ryder)*

G. A. Khoroshev, "Application of the Similarity Principle to the Study of Oscillations Excited by Cavitation", *Akusticheskii Zhurnal*, v. 5, no. 4, 1959, pp. 472-9. Translation in Soviet Physics-Acoustics (Am. Inst. Physics), v. 5, no. 4, 1960, pp. 485-92.

The similarity principle is applied to the problem of determining the intensity and frequency of oscillations excited by cavitation in hydraulic mechanisms. The definitive similarity criteria for oscillations elicited by cavitation in a fluid flow are the Euler number (Eu), the Stokes number (Stk), and the relative air content (q) of the fluid. Equations are given which make it possible, in the simulation of the cavitation noise of geometrically similar systems, to calculate the quantity of air, the size of the air bubbles, and the frequency and intensity of the spectral components of noise. The solution to the problem of the simulations of vibrations excited by cavitation in a fluid is closely related to the determination of the resonance characteristics of the systems. Therefore, the most immediate problem is that of creating a simple and reliable method for measuring these characteristics in the acoustic frequency range. The condition for the simulation of the onset of an intense increase in the vibration level in the low- and middle-frequency range is that Eu, Stk, and q be held constant in comparable systems. *(Abstractor: Edward H. Loeser)*

B. Jakobsson and L. Floberg, "The Centrally Loaded Partial Journal Bearing", Chalmers Tekniska Hogskola — Handlingar (Chalmers Univ. Technology—Trans.) n. 214, 159, 34 pp.

Performance characteristics for centrally loaded partial bearings are presented for bearing angles of 360, 180, 120 and 60 degrees and length to diameter ratios of ¼, ½, 1 and 00. Tables and diagrams are presented for load capacity, oil flow, power loss, and relative power loss. It is demonstrated how to design optimum bearings with minimum power loss for given values of load capacity, angular velocity, and minimum allowable oil film thickness. *(Abstractor: H. J. Connors)*

■ *Second in a series of articles designed to promote broader understanding of colloidal dispersions.*

the strange case of element 6

Any "private eye" worth his Periodic Table knows that Element 6 is simply carbon. Yet this seemingly ordinary material is the heart of a fascinating and commercially important story. For not only is carbon the basis of all organic chemistry — and the almost infinite diversity of compounds which this science includes—but it is also a highly useful material in an extensive variety of essentially pure forms. These exist because of the unusual property of carbon to exhibit itself in many forms ranging from those so minutely crystalline as to be regarded as amorphous to the well-defined crystalline allotropes.

Amorphous carbon can be produced by heating almost any organic compound in a limited supply of air. Carbon black, lampblack, bone black, charcoal and coke, which are made in this manner, find wide industrial application as pigments, fillers, adsorbents or fuel.

A second basic form, diamond, sometimes called a girl's best friend, is quite unlike other carbons because of its tetrahedral crystal structure. It is among the hardest of known substances, has high density and is a poor conductor of electricity and heat. Grades not of gem quality because of undesirable inclusions are still highly important in industrial cutting and polishing operations.

Graphite, the form of carbon so essential in hundreds of lubrication uses, possesses a high degree of laminar crystallinity. Commercially available natural grades vary widely in physical characteristics and purity depending upon their geological character and means of recovery. When intended for use in lubricants, natural graphites are subjected to careful sorting and flotation techniques to remove siliceous mineral impurities, freed from the graphite matrix by fine grinding.

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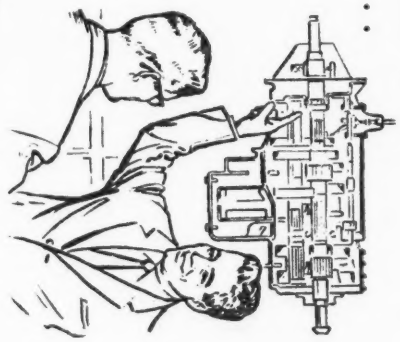

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Patent Abstracts

Compiled by Ann Burchick
Aluminum Co. of America

Process for Making a Lithium-Calcium Base Grease, Patent #2,929,781 (A. Beerbower, Rosemary O'Halloran and H. G. Vesterdal, assignors to Esso Research & Engineering Co.) A process for preparing a concentrate comprising mineral oil and about 2 to 8 molar proportions of lithium soap per one molar proportion of calcium soap, which comprises mixing C_{12} to C_{30} fatty acid, dry calcium hydroxide, dry lithium hydroxide monohydrate and about 10 to 60 wt. percent, based on the weight of said soap concentrate, of a mineral lubricating oil, heating said mixture at a temperature of about 345 F and under a pressure of about 120 p.s.i.g. for about 10 minutes to effect saponification, and then releasing said pressure and applying vacuum to substantially completely dehydrate said concentrate.

Physical Combination of Calcium and Lithium Hydroxy Stearates for Forming Greases, Patent No. 2,929,782 (L. W. Sproule and W. C. Pattenden, assignors to Esso Research & Engineering Co.) A lubricating grease comprising a major amount of mineral lubricating oil and a grease thickening amount of a mixed-metal thickener prepared by cosaponifying in said lubricating oil 12-hydroxy stearic acid with lithium base and calcium base, heating to a temperature of 275 to 315 F to dehydrate, and cooling to form said grease, wherein the proportion of lithium to calcium base is such that said mixed-metal thickener consists of 18 to 22 wt. percent lithium 12-hydroxy stearate and 82 to 78 wt. percent of calcium 12-hydroxy stearate.

Lubrication Oil Compositions Containing Stabilized Salt Suspension, Patent #2,929,783 (A. J. Morway, assignor to Esso Research & Engineering Co.) A lubricating composition consisting essentially of a dispersion of about 0.5 to 50 wt. percent of calcium acetate in lubricating oil, which is stabilized against calcium acetate precipitation with about 0.05 to 1.0 parts by weight per part by weight of calcium acetate of a non-metalic surface active agent selected from the group consisting of ionic and cationic surface active agents containing 5 to 200 polyalkyleneoxy groups having 2 to 4 carbon atoms per group and having at least one terminal hydroxy group in the molecule.

Novel Composition of Improved Lubricating Properties Comprising a Fluorochloro Polymer, Patent No. 2,927,895 (D. E. Neunherz, assignor, by mesne assignments, to Minnesota Mining & Mfg. Co.) A novel lubricating composition having improved load-carrying properties which consists essentially of an admixture of a distillable open chain telomer of trifluorochloroethylene containing a plurality of trifluorochloroethylene monomer units and chlorine terminal groups having a molecular weight between about 300 and about 2300, and a mineral oil having a viscosity between about 870 centistokes at 0 degrees F and about 25 centistokes at 210 F, the weight ratio of telomer to mineral oil being between about 0.01:1 and about 0.2:1.

Lubricating Compositions Containing Oxime Derivatives, Patent #2,929,784 (A. J. Morway and J. H. Bartlett, assignors to Esso Research & Engineering Co.) A lubricating composition comprising a major proportion of a lubricating oil and about 5 to 40 wt. percent of a complex consisting essentially of about 30 to 75 wt. percent of a metal salt of acetic acid, about 10 to 20 wt. percent of a metal salt of an aldoxime having the general formula RCH=NOH wherein R is an aliphatic hydrocarbon radical having from 6 to 9 carbon atoms, and the remainder of said complex being a material selected from the group consisting of a metal salt of intermediate molecular weight carboxylic acids having from 7 to 10 carbon atoms per molecule and a metal soap of high molecular weight carboxylic acids having from 12 to 30 carbon atoms per molecule, said metal being selected from the group consisting of alkali and alkaline earth metals.

Viscosity Index and Oxidation Stability of Lubricating Oil, Patent #2,928,788 (J. L. Jezl, assignor to Sun Oil Co.) Method for preparing lubricating oils having high viscosity index and good oxidation stability which comprises extracting mononuclear and polynuclear aromatic hydrocarbons from a petroleum lubricating oil charge stock: contacting the resulting lubricating oil, from which mononuclear and polynuclear aromatic hydrocarbons have been extracted, with a selective solvent for aromatic hydrocarbons, said solvent containing aromatic hydrocarbons more concentrated in polynuclear aromatic hydrocarbons than the total hydrocarbons previously extracted from the oil; and separating solvent from lubricating oil.

Penetrating Oil, Patent #2,930,759 (R. N. Watts, assignor to Esso Research & Engineering Co.) An improved lubricating oil of high spreading and penetrating ability consisting essentially of one volume of a synthetic lubricating oil boiling above 400 F, which is obtained as a bottoms fraction in the distillation of a crude C_8 Oxo alcohol, and about 0.5 to 4 volumes of a monohydric alcohol having in the range of 1 to 6 carbon atoms per molecule, wherein said C_8 Oxo alcohol is formed by subjecting a C_7 olefin to the action of carbon monoxide and hydrogen in the presence of a cobalt catalyst at a temperature of about 200 to 400 F and under a pressure of about 30 to 400 atmospheres to form an aldehyde which is hydrogenated to form said alcohol.

Lithium-Calcium Greases, Patent #2,929,-780 (Rosemary O'Halloran, assignor to Esso Research & Engineering Co.) A method of making a fibrous grease having improved resistance to boiling water which comprises forming a lithium soap of a fatty acid having a chain length in the range of 12 to 30 carbon atoms and an average iodine number less than 40, separately forming a calcium soap of a fatty acid having a chain length in the range of 12 to 30 carbon atoms and an iodine number in the range of 75 to 150, and then blending said lithium and calcium soaps in a lubricating oil menstruum at a temperature below that at which the lithium grease undergoes a phase change, the ratio of lithium soap to calcium soap in said menstruum being in the range of 2:1 and 8:1, the amount of said soaps being in the range of 5 to 40 wt. percent based on the final grease composition, and the iodine number of said final grease composition being in the range of 30 to 50.

(*Continued on page* 197)

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PATENT ABSTRACTS

(*Continued from page* 195)

Manufacture of Lubricating Oils, Patent No. 2,952,610 (J. Van Dyck Fear, assignor to Sun Oil Co.) Process for the production of lubricating oil, wax and carbon black oil which comprises contacting a hydrocarbon fraction, derived from catalytically cracking a gas oil and boiling mainly in the range of 500-920 F., with a solvent which preferentially dissolves aromatics, the volume of solvent being less than the volume of oil but sufficient to extract a preponderant proportion of the aromatics from said fraction, separating solvent from a first raffinate containing wax and unextracted aromatics and from the extract to yield a carbon black oil having a high Bureau of Mines Correlation Index, dewaxing the first raffinate in the presence of a dewaxing solvent and recovering a wax fraction, separating the dewaxed first raffinate from the dewaxing solvent, contacting the dewaxed first raffinate with a solvent which preferentially dissolves aromatics, and recovering a high viscosity index lubricating oil as a second raffinate.

Anti-Corrosion Compositions, Patent No. 2,956,020 (J. Suprin and F. Soldano, assignors to Esso Standard Societe Anonyme Francaise) An anti-corrosion composition comprising: a major amount of a hydrocarbon oil; 0.1 to 3 wt. percent of an alkali metal petroleum sulfonate having a molecular weight in the range of 300 to 600; and 0.01 to 3 wt. percent of the dehydrated amide reaction product of 2 moles of a C_8-C_{24} fatty acid and one mole of ethylene diamine.

Metal Terephthalamate-Thickened Greases Containing Soaps of Fatty Acids as Bleeding Inhibitors, Patent No. 2,956,021 (B. W. Hotten, assignor to California Research Corp.) A grease composition comprising a major proportion of an oil of lubricating viscosity, a metal salt of a terephthalamic acid in amount sufficient to thicken said oil to the consistency of a grease, and a metal soap of an unsubstituted fatty acid in amount sufficient substantially to inhibit bleeding of said grease composition wherein said metal, in each instance, is a metal selected from the group consisting of alkali metals and alkaline earth metals.

Spot Test Method for Estimating Neutralization Number of a Mineral Oil, Patent No. 2,953,439 (W. E. Elliott, R. E. Reinhard and E. P. Schram, assignors to Allis-Chalmers Manufacturing Co.) A spot test for determining whether the neutralization number of a mineral oil is at, above or below a predetermined critical value by observing the colors developed by an organic acid-base indicator exhibiting an approximately equal distribution of a first and second color in an oil spot having a neutralization number at said predetermined critical value, said method comprising the steps of: placing a selected quantity of a color change adjustor solution consisting essentially of sodium carbonate on a porous medium possessing uniform absorptive properties to form a spot thereon, said color adjustor solution having sufficient neutralizing strength so that when a spot formed on said porous medium by said solution is combined with a spot formed by a standard liquid having a neutralization number of said predetermined critical value, the addition of said organic acid-base indicator will develop a color pattern having an approximately equal distribution of said first and second colors; placing a selected quantity of said mineral oil to be tested within said spot formed by said color change adjustor solution to form an oil spot thereon; and depositing a selected quantity of an organic acid-base indicator consisting essentially of a universal indicator on said oil spot, the predominance of one of said colors over the other providing an estimate whether said oil is above or below said predetermined critical value.

Microcrystalline Petroleum Wax Impregnating Composition for Insulated Electric Cables, Patent No. 2,956,036 (A. King, assignor to British Insulated Callender's Cables Limited) A microcrystalline petroleum wax impregnating composition for use in the manufacture of fully impregnated non-draining electric cables comprising as its major ingredients from 20% to 100% by weight, on the weight of the composition of a mixture of microcrystalline petroleum wax and a synthetic hydrocarbon wax product of the Fischer-Tropsch process having a melting point within the range 85 C to 120 C, the weight of said synthetic wax amounting to between 1% and 40% of the weight of the composition, and the microcrystalline wax constituting at least 30% of the wax mixture.

Cable Pulling Lubricant Comprising a Clay-Organic Complex, Patent No. 2,956,019 (L. B. Sand, J. F. Wygant and P. T. Mecozzi, assignors to Standard Oil Co.) A lubricant composition for facilitating the pulling of electrical cables through metal conduits consisting essentially of between about 60 and 65 weight percent of glycerine, between about 25 and 30 weight percent of a swelling sodium bentonite, between about 5 and 10 weight percent of a layered mineral filler of a particle size to pass through a 200 mesh screen and having no interlayer water selected from the group consisting of talc, mica, pyrophyllite and kaolin, and between about 1.5 and 2.5 weight percent of a clay-deflocculating and a foam-forming detergent comprising a compound selected from the class consisting of an alkyl aryl sulfonate and an alkyl sulfate.

Heavy Duty Lubricating Oil, Patent No. 2,954,344 (J. R. Miller, assignor, by mesne assignments, to Esso Research & Engineering Co.) A lubricating oil composition of improved stability which consists of synergistic amounts in the range between about 0.5% and about 2.0% by weight of an ortho-alkylated phenol consisting of 2,6 ditertiary butyl 2 dimethyl amine para-cresol, between about 1% and about 5% by weight of an alkaline earth metal sulfonate inhibitor containing a co-neutralized sulfurized nonyl phenate, said alkaline earth metal sulfonate and co-neutralized sulfurized nonyl phenate being in a ratio of about 2:1, and between about 93% and about 98.5% by weight of a lubricating oil.

Process of Treating Hydrocarbons and Product, Patent No. 2,955,084 (J. D. Bartleson and H. E. Alford, assignors to The Standard Oil Co.) A method of processing hydrocarbon base lubricating oil having a viscosity at 100 F of from 10 to 500 centistokes to yield a product having a higher ash content and a greater detergency which comprises reacting the oil with an amount within the range from about 0.5 to about 3% by weight of the oil of a strong metal base selected from the group consisting of metals of groups I and II of the periodic table at about 350 F for a time sufficient to effect reaction but less than two hours while blowing with nitrogen in the presence of oxygen.

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Tom Osters, Cleveland Graphite Bronze Div., Clevite Corp., is shown discussing "Sleeve Type Bearings—Materials, Applications, and Causes of Failure" at the Pittsburgh Section Meeting on February 9.

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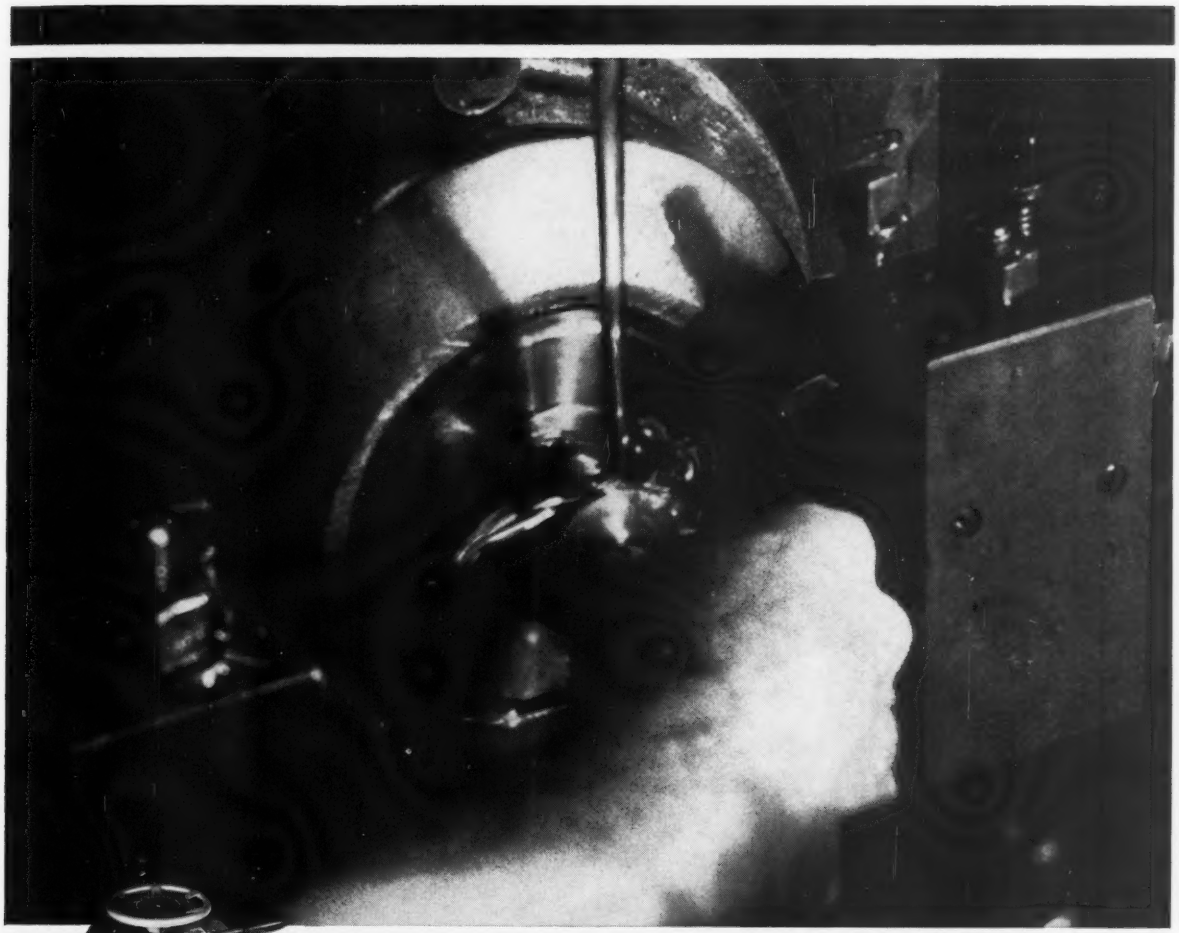

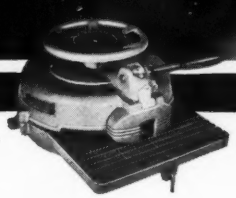

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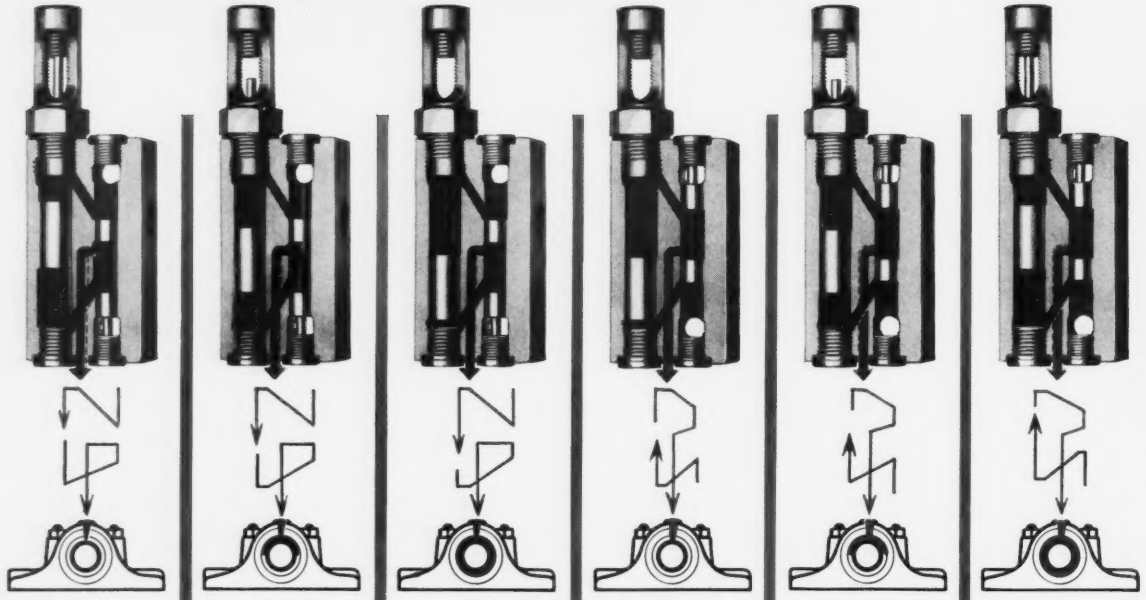
Here's design simplicity

Farval's Time-Tested Dualine Valve



1

(In red) Lubricant under hydraulic pressure enters inlet at top right — pushing slide valve down and filling upper diagonal passage and chamber above main piston.

(In blue) By this movement, lower head of piston slide valve uncovers lower diagonal passage leading from the main piston chamber. This chamber is full of lubricant from the previous operation.

2

(In red) Lubricant under pressure entering through upper inlet port and into main chamber continues to force main piston downward —

(In blue) discharging lubricant through lower diagonal passage to vertical passage and to outlet port leading to bearing.

3

(In red) Lubricant entering from upper port has now forced the main piston to end of its stroke, and thus the full measured charge below piston has been delivered to the bearing.

Note that indicator stem has also moved down, indicating main piston has reached end of its stroke, and that no more lubricant will be delivered from this operation.

4

(In blue) Lubricant under hydraulic pressure enters inlet at bottom right — pushing slide valve up and filling lower diagonal passage and chamber below main piston.

(In red) By this movement, upper head of piston slide valve uncovers upper diagonal passage leading from the main piston chamber. This chamber is full of lubricant from the previous operation.

5

(In blue) Lubricant under pressure entering through lower inlet port and into main chamber continues to force main piston upward —

(In red) discharging lubricant through upper diagonal passage to vertical passage and to outlet port leading to the bearing.

6

(In blue) Lubricant continuing to enter under pressure from the lower port has now forced main piston to the end of its stroke, and thus the full measured charge above piston has been delivered to the bearing.

Indicator has reached its top limit, showing the job is done.

That's why *FARVAL DUALINE* is today's most dependable, positive system of centralized lubrication

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Farval Division
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Farval Studies in Centralized Lubrication No. 255

Only Farval has all these vital features

No Springs
No Check Valves
No Small Ports
Measures By Piston Displacement
Has But Two Moving Parts
Is Individually Adjustable
Will Distribute Either Oil Or Grease
A Positive Indicator At Every Bearing